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BULLETIN

OF THE

INTERNATIONAL RAILWAY CONGRESS

ASSOCIATION

(ENGLISH EDITION)

[621. 392. (.493) & 625. 143 (.493)]

Rail welding on the Belgian National Railways,

by E. DESORGHER,

Engineer, Belgian National Railways Company.

SUMMARY.

PRACTICAL APPLICATIONS.

. Rails suitable for re-use.
  Introduction.
  Reconditioning worn rails for further service.
  Original method.
  New method.
  Principles of flash-butt (resistance) welding.
  Description of latest equipment for reconditioning worn rails on the Belgian National Railways.
New rails.
Rails joining two rails of different sections.
Handling and transporting long welded rails.

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RELIABILITY OF WELDED JOINTS IN MAIN LINES.

CONCLUSIONS.

* * *

PRACTICAL APPLICATIONS.

I. — Rails suitable for re-use.

Introduction.

The Belgian National Railways Company has, since its formation in 1926, steadily pursued in every department a policy of rational and economical working.

The value of the general permanent way materials used in the maintenance and renewal of equipment and the extension of the system represents about 10 % of the annual expenditure — a very large item. A substantial source of saving lies in a better re-use, after suitable selection and reconditioning, of worn materials, withdrawn from the track for various reasons.

Such reconditioning is done by the Company itself, in works specially equipped for the task, and is systematically studied with the object of considerably and economically improving re-usable material, so as to give it a uniform quality and make it capable of giving, often in place of new material, perfectly satisfactory service on important lines.

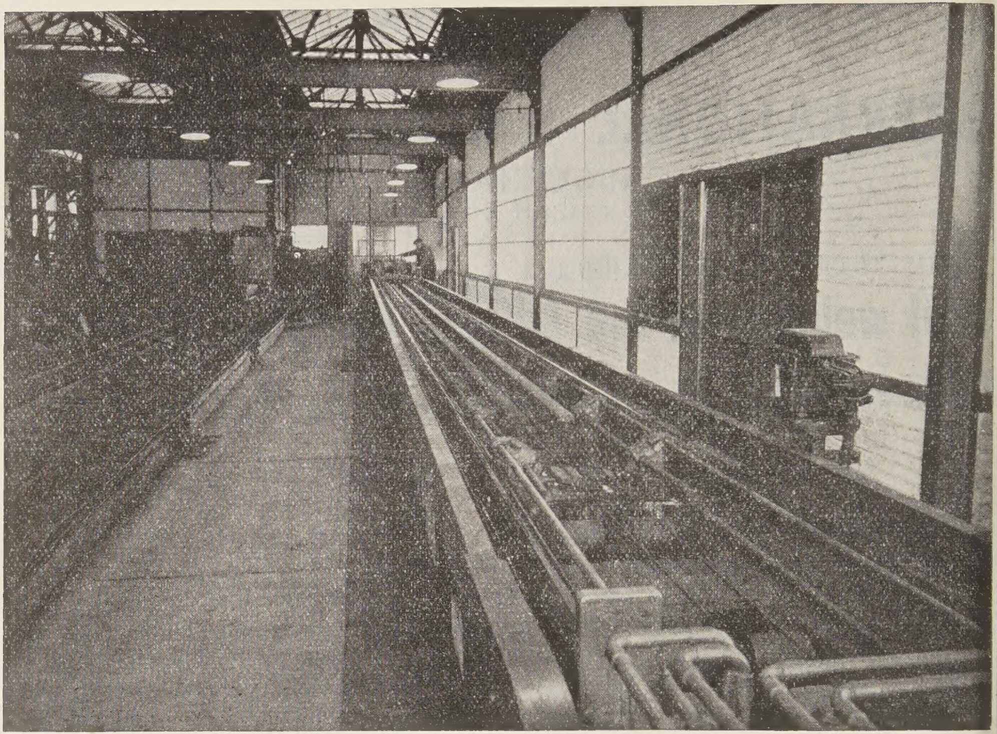


Fig. 1. — Stand for planing worn rail heads.

Among permanent way materials the first place obviously belongs to rails, as the Company removes some 50 000 to 60 000 tons of worn rails annually from its lines, of various cross sections and of lengths varying from 9 to 18 m. (29' 6 5/16" to 59' 5/8").

Reconditioning worn rails for further service

Original method.

The rails are collected systematically at a single depot at the centre of the railway system. After a careful selection by specially trained gangs, who follow very exact instructions, rails suitable for further service are subjected to certain machining, comprising notably :

a) bevel planing of the upper face of the rail head :

Features of the equipment (fig. 1) :

A stand, 24 m. (78' 9") long, to take 2 rails, and served by a tool carriage for two pairs of tools of 40 × 35 mm. (1 9/16" × 1 3/8") section.

The carriage is moved by an endless cable, wound round a controlling drum, at a speed of 10 m. (32.8') per minute.

Rails are placed in position and removed on rollers by means of an electrically driven winch at a speed of 50 m. (164') per minute.

Hydraulic pressure holding rails on the

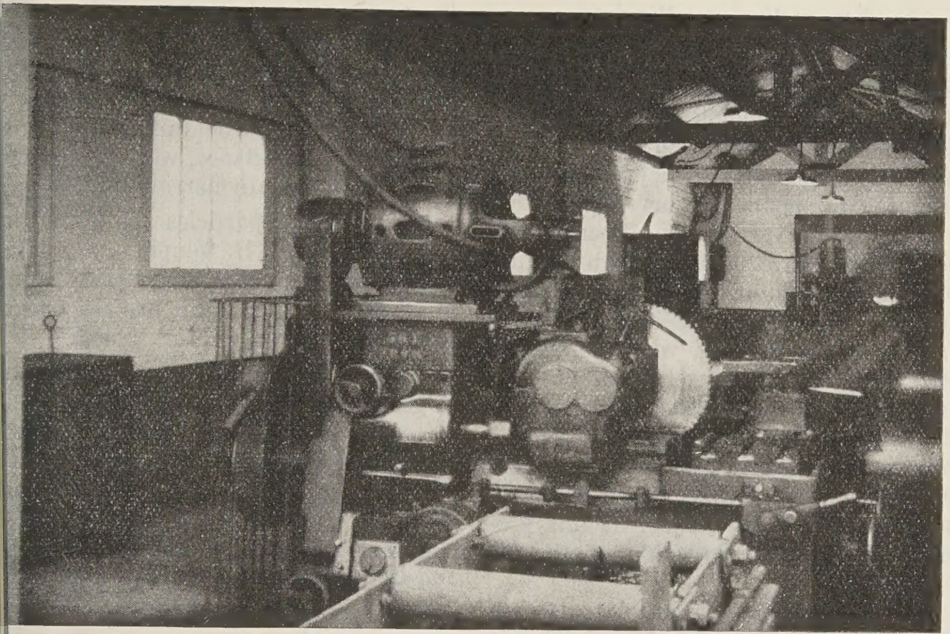


Fig. 2. — Combined rail sawing and drilling machines.

nd : 450 kgr. per lineal metre (3 023 lb. lineal foot).

The machine absorbs 40 H.P.

Output : 100 rails per 8-hour day.

Staff required : 7.

b) Sawing off battered and worn rail ls at the fishing spaces, and drilling v fishbolt holes in the rail web.

Features of the equipment (fig. 2) :

combination machines for simultaneous ting off and drilling, with 550 mm. 11/16") diameter saws having inserted th of special steel, and drill holders with pindles for drills up to 40 mm. (1 9/16") meter, the feed and speed being adjustable.

Width of saw cut : 6 mm. (1/4").

Time taken by one combined sawing off drilling operation : 3 minutes.

orse-power absorbed per machine : 12.

Output per 8-hour day : 85 rails.

Number of men in attendance : 6.

After machining, the rails are stacked in piles, composed of rails of similar section and degree of wear, the latter being measured to within 1/2 mm. (0.0197"), to enable them to be accurately selected for such further service as they are suitable for.

This process eliminates the most important defects found in old rails and allows of their being used again under good conditions according to their amount of wear.

A disadvantage arising from the shortening of the rails is that more fished joints are necessary. These are not only weak points in the track, but expensive to maintain : In addition short rails also conduce to rough riding on curves.

New method. — Welding.

These disadvantages have been removed by the recent progress in welding, for it is now an economical proposition to weld shortened rails end to end, so reducing the number of fished joints and facilitating the laying of curved track.

Systematic experiments, described in detail below, have shown that, in the present state of technical development, of all known processes that called « *flash-butt (resistance)* » welding, when performed automatically with a machine, is the only one which gives a sound welded joint; alteration in the texture of the steel is only found within a very limited zone on each side of the weld, and tensile characteristics of a rail welded by this process most nearly approach those of the body of the rail.

The work being done on mass-production lines, the price of a welded joint is only half that of a fished joint.

Principle of resistance welding.

The welding process comprises three essential stages :

1. Pre-heating of the rail ends to be welded;

2. Their continuous fusing over a very short distance;

3. Powerful forcing together of the ends.

In the modern machines these three stages follow each other in this order under automatic control, which limits the preheating time, cuts down the welding time and ensures the correct performance of each operation. A very strong current at a low voltage, derived from the secondary of a transformer fed from the distribution system, and controlled by a cut-out and a regulator, is fed to 2 jaws, one fixed, the other movable, which firmly grip the rail ends that are to be welded The temperature of these ends is rapidl raised to a high figure by flashes of cur rent produced by repeatedly bringing u and withdrawing one rail, owing to th high contact resistance, while the heatin zone is kept within narrow limits.

Incandescent particles are thrown of and the heating is complete when the come from the whole of the cross sectio to be welded, showing it has reached th temperature required for fusion.

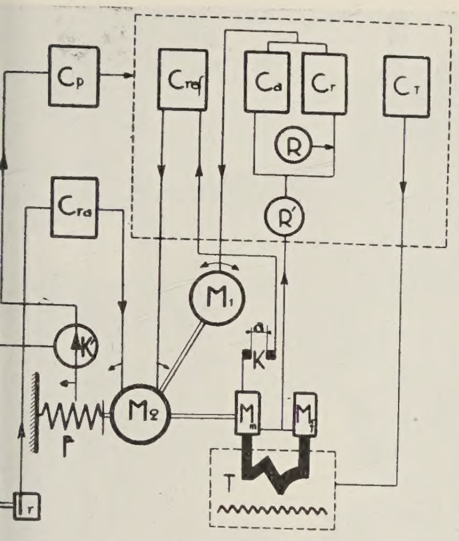
At this moment the automatic contr stops the backward motion of the mov able jaw, which then continues to mov forward towards the rail held in the fi ed jaw, over a stroke decided beforehan while the metal of the parts to be welde which does not come into contact mel and is thrown off in sparks.

Towards the end of this process th progress of the mobile jaw is automati ally accelerated and exceeds that at whic the metal is melting, the two faces bein powerfully forced together, thanks to th reduced heating zone, and a well finis ed weld is produced, from which all trac of oxide has been expelled.

Working and characteristic features o modern machines for welding rails b the electrical resistance process.

The welding shop which was added t the Belgian National Railways Company rail reconditioning plant in 1934 contai 2 automatic machines for butt-welding b the electrical resistance process, whic work as follows (fig. 3) :

(a) Starting up, after clamping in th jaws the parts to be welded; the ope ation of the forward motion switch energises the main contactor C_p which turn energises the whole of the conta tors contained in the dotted rectangle



g. 3. — Simplified diagram of connections for automatic butt welding machine.

Explanation :

C_p, C_{ra}, C_{ref}, C_a, C_r, C_T : Contactors.
F : Spring.
I_a, I_r : Switches.
K, K' : Contact.
M_m, M_f : Jaws.
M_1, M_2 : Motors.
R, R' : Relays.
T : Welding transformer.

gure 3, except the contactor C_{ref} con-
olling the forcing together of the rails.
(b) Heating, then fusion welding by
inging the rails together and separat-
g them : the contactor C has already
ergised the welding transformer T and
e forward motion contactor C_a has
rted up the motor M_1 which controls
e movable jaw M_m; the latter advances
til the rails touch, which practically
ort-circuits the secondary winding of
e transformer T, causing its voltage to
op to a very low figure. The voltage
ay R' operates, causing contactor C_a
open, and the backward motion con-
tor C_r, to pick up under the control of
the time lag relay R; the motor M_1 is reversed and the rails become separated; as soon as the transformer secondary voltage is re-established relay R' returns to its original position, contactor C_a again closes and the cycle of operations is repeated until the welding temperature is reached.

From that moment, in consequence of the fusion of the metal, the rail ends are no longer brought into contact as the jaw M_m advances.

The latter then moves over its stroke *a*, adjusted beforehand, and contact K is closed, bringing the forward motion contactor C_{ref} into operation; the powerful high-speed forward motion motor M_2 starts up, accelerates the movement of the mobile jaw and forces the rail ends into contact.

At this moment a special device cuts out the voltage relay R', motor M_2 continues to force the two welding faces strongly together and compresses the calibrated spring F; after a stroke corresponding to a pre-determined pressure, contact K', which controls the pressure, opens, opening in its turn contactor C_p and the machine is stopped; the weld is completed.

(c) Withdrawal of the movable jaw after removal of the welded parts; the operation of switch I_r energises the high-speed backwards motion contactor C_{ra}, which sets motor M in reverse motion.

Jaw M_2 resumes its original position and the machine is ready for another operation.

Principal features of the welding machines (fig. 4) :

Maximum welding capacity, 10 000 mm² (15.5 sq. inches) of section.

Weight : 8 000 kgr. (17 640 lb.).

Maximum gripping pressure at the jaws : 28 tonnes (27.5 Engl. tons).

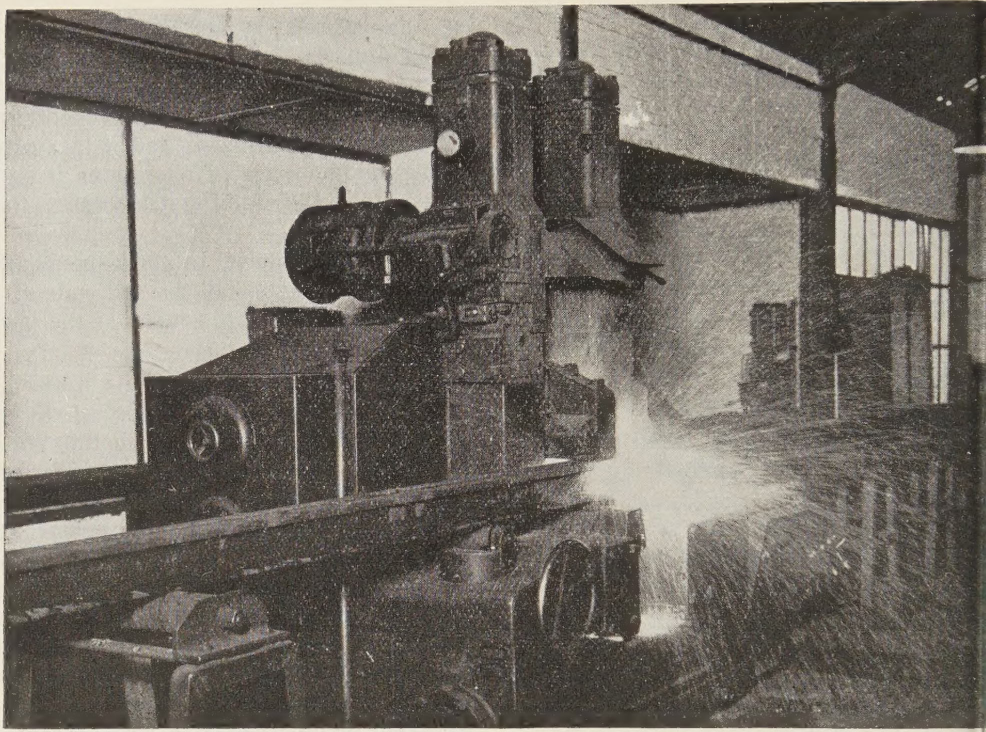


Fig. 4. — Automatic butt welding machine.

Maximum compression pressure : 20 tonnes (19.7 Engl. tons).

Power derived from a static 6 600 V/220 V oil-cooled transformer, of 200/300 KVA capacity.

Single-phase 230 V/5-7 V welding transformer.

All parts water cooled.

Safe working ensured by a group of automatic safety and interlocking devices.

With these machines all the operator has to do after making the complete preliminary adjustments when the machine is being put into service, and securing the rails properly in the jaws, is limited to switching on by the pedal switch I_a, removing the welded pieces and operating switch I_r.

Reconditioning worn rails.

In the welding shop, the rails, previou ly sorted, planed and their battered en cropped, are welded into normal lengt of 35 m. and 52.50 m. (114' 10" an 172' 3") *with corresponding short lengths for use on curves.*

The 35-m. rails with not more tha 4 mm. (5/32") wear on the running su face, are used again on secondary ru ning track. They are prepared in such way as to permit of the so called « true fishing at the joints, in which the fis plates join the two halves of the sam rail (fig. 5).

The building up of long welded rai so as to achieve this necessitates, it

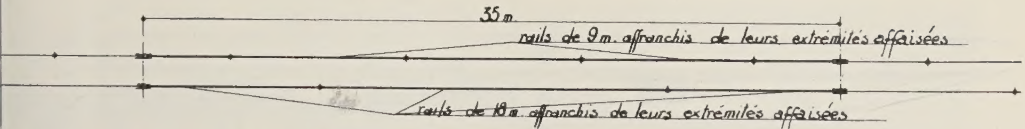

35 m
rails de 9m. affranchis de leurs extrémités affaisées
rails de 18 m. affranchis de leurs extrémités affaisées

Fig. 5. — Layout of reconditioned rails with « true » fished joints.

Note : Rails de 9 m. (18 m.) affranchis... = 29' 6 5/16" (59' 5/8") rails with battered ends cropped.

rue, an additional weld per rail. A working plan has to be made for each site to ɔe laid under such conditions, each rail ɔf a series being numbered, including the hort ones for the curves, so that the ends o be joined come from the same rail, awn through in the centre. The machinng, loading, transport, unloading and aying have to be done in accordance with his plan.

All these drawbacks are, however, largely compensated for by the good performance of the material in service and the eduction of maintenance costs obtained hanks to :

(a) the fishing angles and spaces in djacent rails being identical;

(b) the perfect alignment between the unning surfaces at the joints, which is ot always obtained with new rails and s always wanting when worn rails are laced next to each other, due to varying onditions of previous service : whether he rails were laid on a straight alignnent or on a curve, vertical, canted, etc.

Before they are sent out a red mark is ainted on all reconditioned rails to show which is the inside running surface. The 52.50-m. (172' 3") rails are used on secondary track, groups of reception roads, marshalling or shunting sidings (fig. 6).

The Belgian National Railways are considering the laying of completely welded sidings as soon as an economical method of welding in situ has been perfected.

Description of latest equipement for reconditioning worn rails on the Belgian National Ralways.

With its complete equipment for this work the Belgian National Railways Company deals with some 60 000 tons of reconditioned rails annually, in a sorting yard and depot covering about 5 ha. (12.35 acres) and served by 6 tracks (fig. 7).

The shops and other equipment are located in the centre, viz. (figs. 7 and 8) :

1. A shop of 100 m² (1 076 sq. ft.), preceded by an unloading bank and fitted with three combined sawing and drilling machines, the two outer machines having two drill holders, and the middle

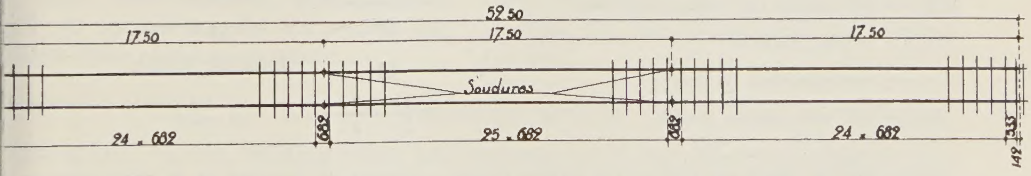


Fig. 6. — Layout of 52.50 m. (172' 3") reconditioned welded rails in sidings.

Note : Soudures = welds.

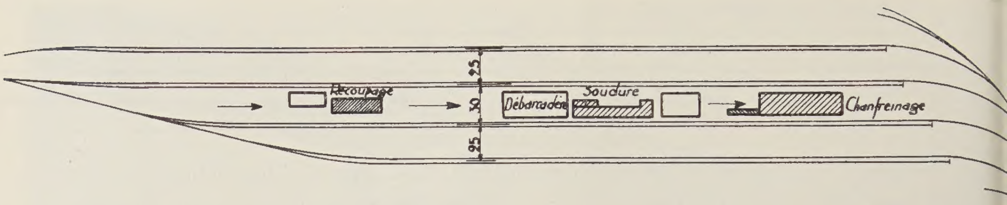


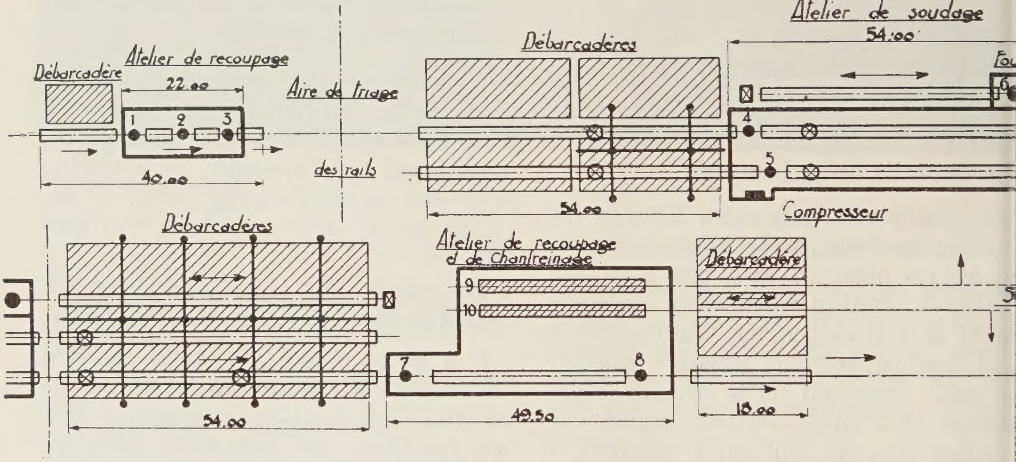
Fig. 7. — Layout of rail reconditioning yard and shops.

Note : Recoupage = cropping stand. — Débarcadère = unloading stage. — Chanfreinage = planing.

one four, for making the « true » type of joint. The distance between the machines can be adjusted by means of a rack, let into the floor.

Rails to be welded have their worn ends sawn off and, as the case may require, have new fishbolt holes drilled at one end; the outer portions of rails i tended for running road service a which need « true » joints are made fro rails sawn at the centre in two equ parts, each of which is drilled with tw fishbolt holes by the centre machine.

2. A shop of 470 m² (5 060 sq. ft



Legend :

1, 2. 3 = rail sawing and driling machines.

4, 5 = welding machines.

6 = weld annealing furnace.

9, 10 = rail head planing stands.

= transporter rollers.

⊗ = driving rollers.

⊠ = electric winches.

= plant for lateral displacement of rails.

Note : Aire de triage des rails = rail sorting ground. — Atelier de recoupage et de chanfreinage = sawing and planing shop. — Atelier de soudage = welding shop.

Fig. 8. — Rail reconditioning shops.

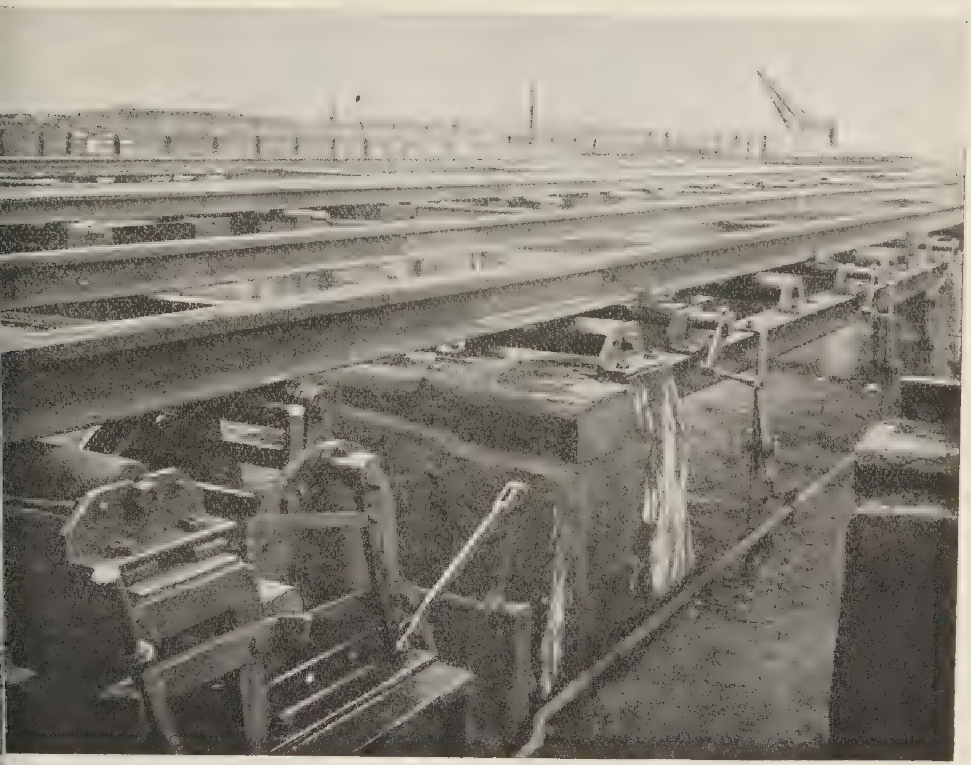


Fig. 9. — Motor driven roller equipment for moving rails lengthwise.

th an unloading bank on each side, ntaining two resistance welding machi- s and an air compressor.

3. A shop of 500 m^2 (5 382 sq. ft.) itaining two combined sawing and lling machines in which rails intend- for main-line service go after welding l are provided with the missing fish- t holes, if required, and trimmed ictly to normal length. This shop also itains two planing stands.

Lengthwise transport of rails always occurs on strong rollers, with adjustable guide pieces (fig. 9) some of which impart their forward motion to the rails and are driven by an electric motor, controlled from a distance. Transverse movement is also obtained mechanically on the unloading stages by means of endless ropes wound on drums and fitted with movable catches which grip the foot of the rail.

The reconditioning process.

Operations in the welding shop are carried out in the following order :

	Mean time.
Cleaning the rail ends to be welded, by means of a pneumatic grinder, to facilitate the passage of the electric current . .	3 min.

	Mean time.
2. Bringing up the rails, fixing them in the jaws of the welding machines, after adjustment for height and alignment . .	2 1/2 mi
3. Welding, performed automatically	2 1/2 mi
4. Release of the welded joint, and immediate trimming of the joint by means of pneumatic chisels, finishing off with hammer and file (fig. 10)	4 min.
5. Removal of welded rail and colour marking of the new inside running surface	1 1/2 mi

Men required for the two machines, operating in co-operation :

Preliminary grinding and bringing rails into position . . .	4 men.
Operating the two welding machines	2 men.
Trimming joints	3 men.
Removing welded rails	2 men.
Total . . .	11 men.

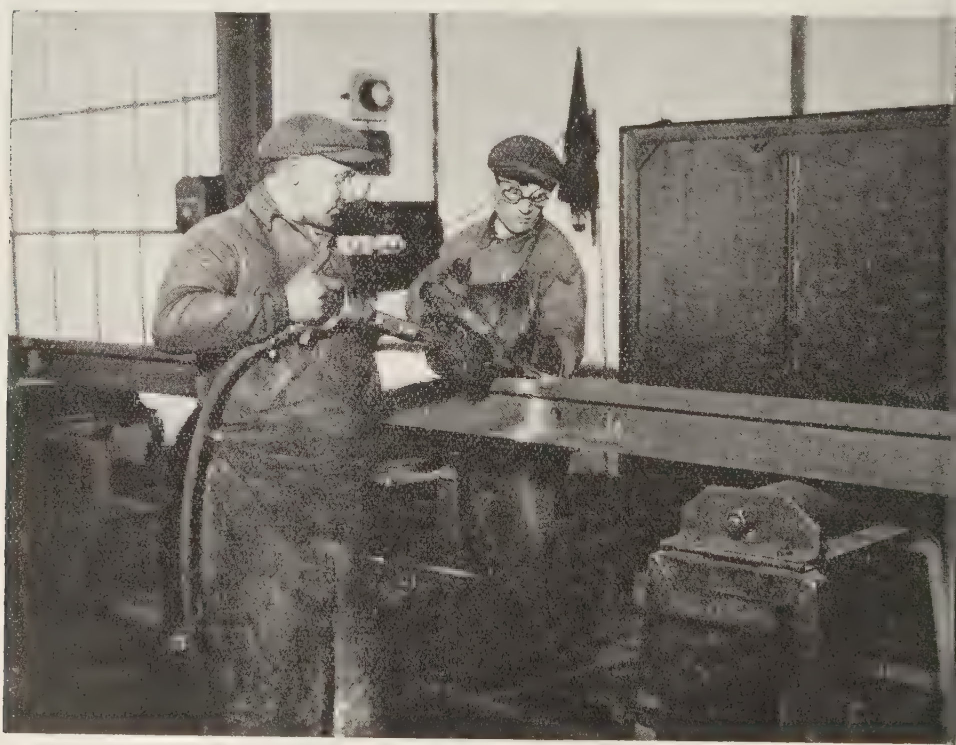


Fig. 10. — Trimming up a welded joint.

Power consumed per joint of 6 700 m^2 (10.38 sq. in.) cross section : 4.5 kwh.

Cooling water required : 800 litres 1 700 Br. gall.) per hour per machine.

Average number of welded joints made y the equipment per 8-hour day : 80.

II. — New rails.

(a) The first welded joints between ew rails were made in Belgium in 1931, hen the track was being renewed in a nnel.

Tunnels being generally rather damp, aterials deteriorate somewhat rapidly them; on the other hand as the tem-erature is relatively constant, expansion d contraction are small, and conse-ently the laying of long rails is par-cularly justified.

Sections of track were laid with 54-m. 77' 2") rails (at the tunnel portals) d 108-m. (354' 4") obtained by weld-g together two or four 27-m. (88' 7") ils, of standard section, weighing 50 r. per metre (100.8 lb. per yard).

Thermit-pressure welding with pre-ating, a well known process and at that me almost the only one with which ere was much experience, was em-oyed.

The actual welding process, carried out ar the laying site, was followed by heat atment in a small oil fired muffle-rnace.

Joints so made have given relatively od performance up to the present.

(b) In 1936 and 1937 two sections of ck, each 24 km. (14.9 miles) long, re laid on the Brussels-Antwerp elec-fied line, with 54-m. (177' 2") rails g. 11), obtained by welding, by the ctrical resistance process, two new 27.014-m. (88' 7") rails with the machines described above. There are 98 wooden sleepers per rail, spaced as shown in figure 12.

The sleepers have ribbed sole plates, fixed to them by two coach-screws; the rails are fixed between these ribs by clips and bolts with spring washers exerting a force of 3 tons.

The joint gap varies from 0 to 18 mm. (45/64") as the temperature varies between 35 and — 10° C. (95 and 14° F.).

All the fished rail ends were heat-treated at the rolling mills on the « Arbed » process described by Mr. J. SERVAIS in the *Bulletin of the International Railway Congress Association*, issue of July 1936.

As a precautionary measure the sleepers were brought closer together at the welded joints.

The latter are treated by reheating, before the rails are laid, to a temperature of 875° C. for 50 minutes in a shed next to the welding shop (fig. 8), in a little tunnel-way furnace using oil fuel (fig 13), with adjustable automatic control and temperature recording device.

The furnace can deal with 5 joints at one time; the rails are brought to it and taken away on transporter rollers by two electric winches. The annealing temperature of 875° C. is gradually reached after some 50 minutes, starting from cold, and 25 minutes starting from a furnace temperature of 300° C. On removal from the furnace the hot joints are subjected to a slight bending upwards, giving a deflection of 6 mm. (1/4"), over a length of about 2 m. (6' 6 3/4"), by screw jacks, with the object of counteracting the sag of treated joints during the air cooling.

With 4 men this equipment turns out 20 joints per 8-hour day.

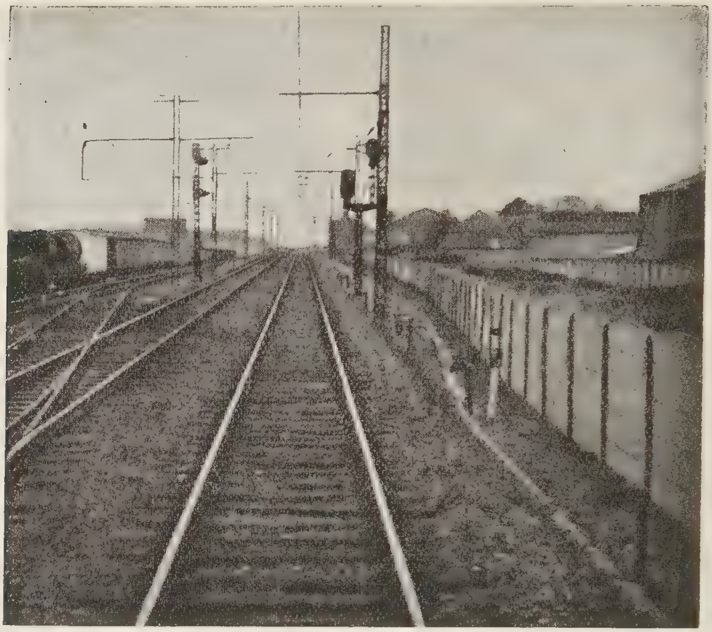


Fig. 11. — Running road laid with 54-m. (177' 2") welded rails.

III. — Joining two different rail sections.

An interesting application is the welding of rails of different sections, or of the same section but worn to a different extent, by which process the cranked fishplates can be advantageously dispensed with.

Cranked fishplates are expensive, their complicated shape rendering their stamping difficult. Moreover, they only perform their function imperfectly, usual not being accurately adapted to the fis ing surfaces, and so frequently leavi small portions of rail ends unsupporte

Then too, when a railway system ha as is frequently the case, rails of diff rent degrees of wear and different se tions, a great variety of cranked fis plates is needed, but the extent to whi each sort is used is very limited, leadi to complications in purchasing them, a to high prices. Most of these difficulti

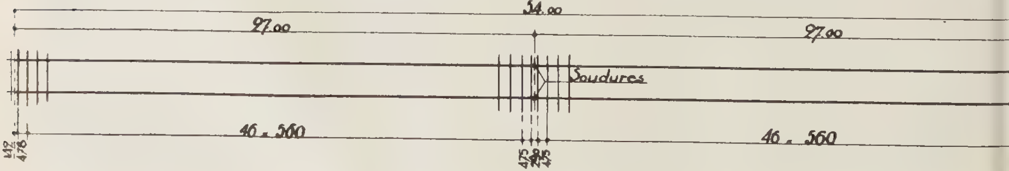


Fig. 12. — Layout for new welded 54-m. rails in running track, showing *distribution of sleepers.*

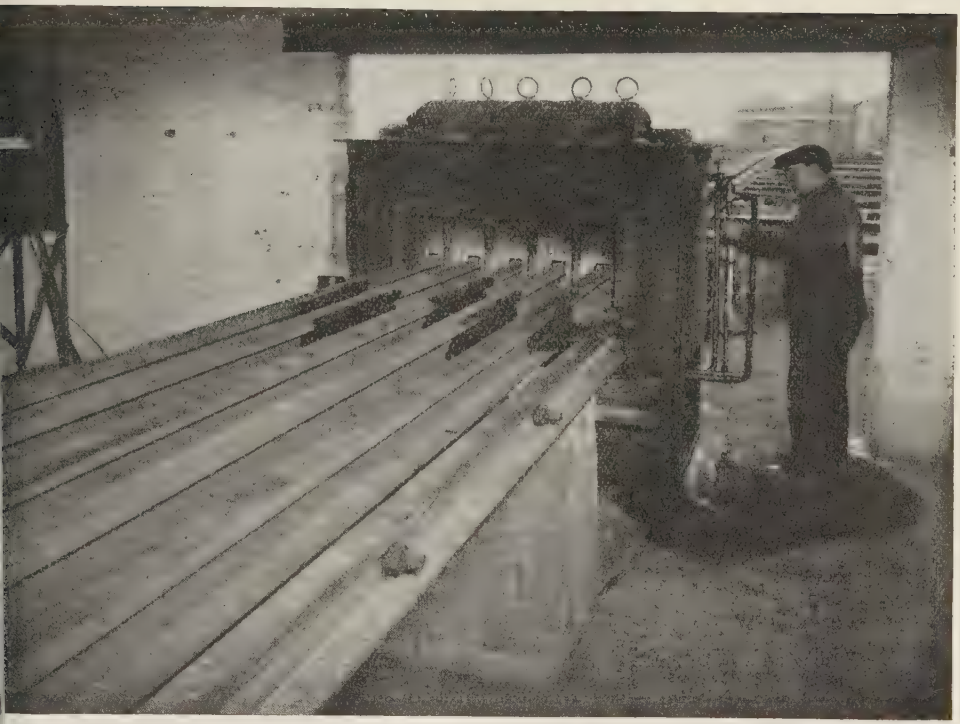


Fig. 13. — Annealing furnace for welded rails.

eliminated by using welded transi-
ı joints, made in the following man-
:

. *Rails of the same section, the diffe-*
ce in wear not exceeding 4 mm.
32").

irect welding of the two rails in the
ner already described.

. *Rails of same section, but differen-*
n wear exceeding 4 mm. (5/32").

Velding of the two rails with the
rposition of a piece of rail 500 mm.
11/16") long, the ends of which, by
ns of a special hot-stamping oper-
n in a powerful screw press, are
e the exact height of the rails to be
ed (fig. 14).

3. *Rails of different sections.*

The same process as in (2) above but using a piece of rail of the heavier section, machined as follows (fig. 15) :

(a) Hot stamping in a press, as described above.

(b) Planing of the rail head and foot of the piece to get, where connection is made with the rails to be joined, the webs symmetrical, the inner running faces A, A', of the heads in line, and equal widths at the rail foot. (This necessitates a slight oblique sawing of the ends of the stamped portion.)

(c) Completion by means of the power hammer and milling.

This method avoids any sudden change in rail section at the weld.

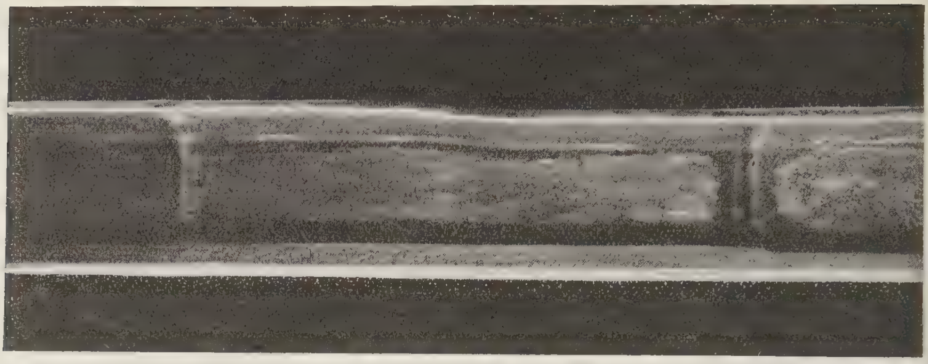


Fig. 14. — Joint rail connecting unequally worn rails.

A right and left-hand piece are needed in the track.

Mass production of these connecting rail pieces takes about two hours each. The complete rails so formed — which are generally 18 m. (59' 5/8") long, are supported on the sleepers at the welded joints as shown in elevation in figure 15.

IV. — Handling and transporting lo welded rails.

Loading.

The long welded rails are loaded wagons at the central depot by stea cranes exerting a force of 10 tonnes the hook, with jib raised; when handli

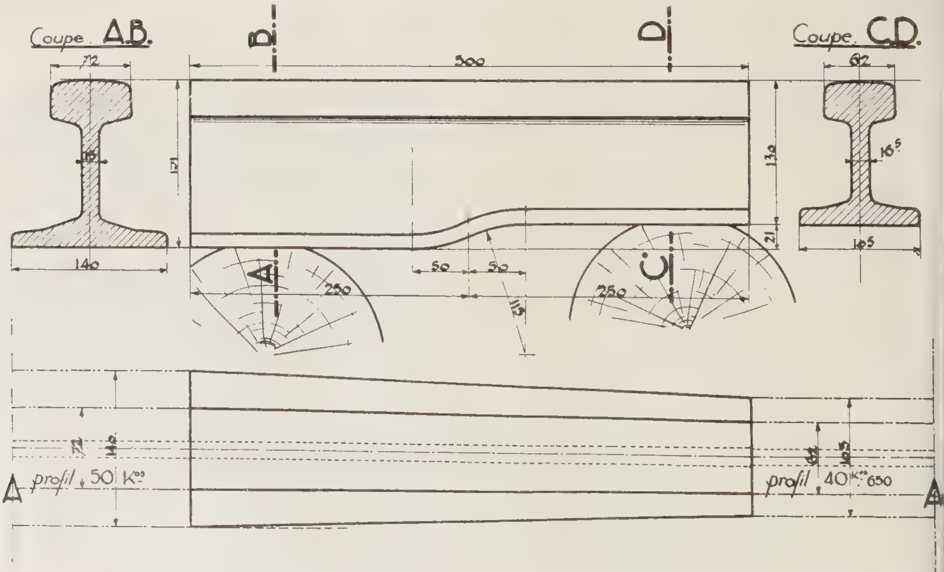


Fig. 15. — Joint rail connecting two welded rails of different cross sections.

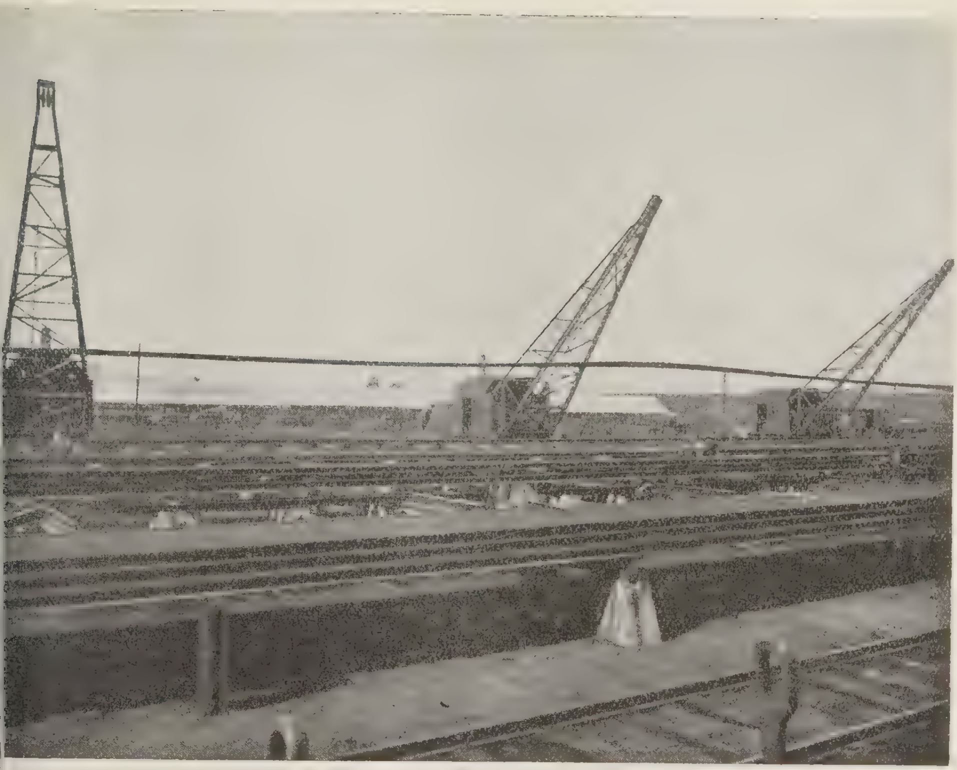


Fig. 16. — Loading long rails on wagons.

35-m. rails, 2 cranes working to-
er are required, 3 being necessary
rails of 52.50 m. or longer (fig. 16).
he maximum number of rails handl-
per crane movement is 3; the number
crane movements per hour is 10 (1).
his equipment will shortly be replac-
by electric overhead travelling cranes,
net hourly working cost of which is
er.

Transport.

he long rails are conveyed on very
, flat bogie wagons, coupled in sufficient number to prevent the load overhanging the frames. As a rule the loads consist of 2 sets of 12 or 13 rails laid heads upwards. The first set rests directly on the floor of the wagons, the second being separated from it by 10 × 10 cm. (4" × 4") timbers spaced about 5 m. (16 1/2') apart over the whole length of the load.

Loads of reconditioned rails are always made up of equal quantities of rails for the inside and outside files and a wire rope, or soft steel wire, is passed through the outer fishbolt holes to secure the rails firmly together (fig. 17).

Lateral displacement is prevented by securing the load against the wagon

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) In practice, a load of 26 long rails is
lled in one hour after which it takes 2
1 hour 30 mins. to secure them in place.

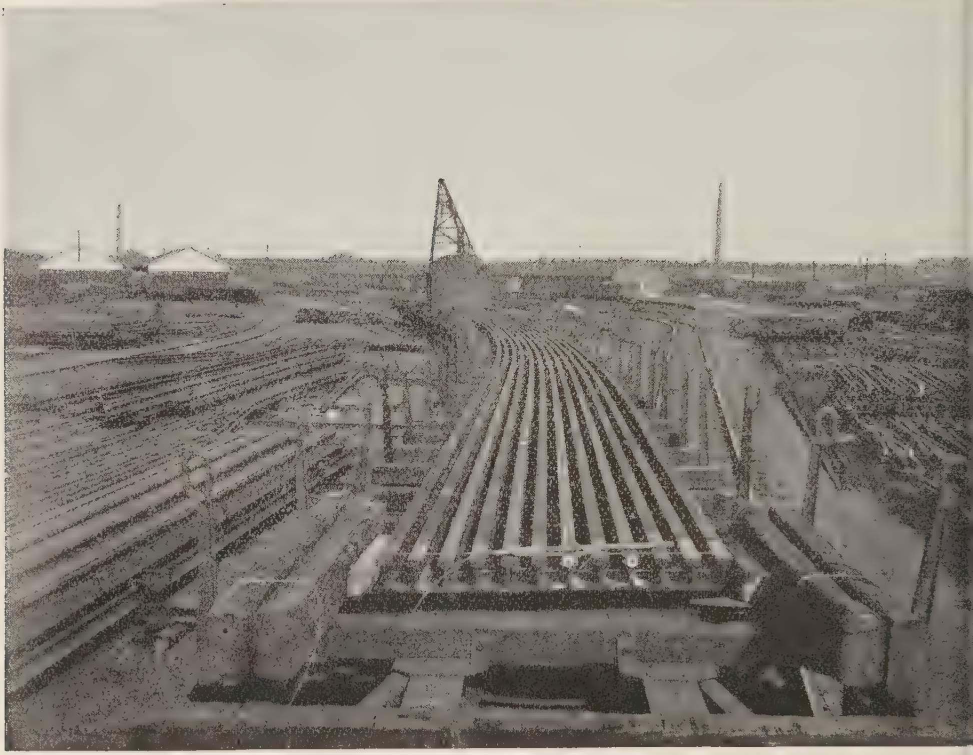


Fig. 17. — Securing long rails loaded on wagons.

stanchions at both ends only, by means of two or three sleepers, bolted together, and by wedges nailed in place, the whole being fastened both to the stanchions and the cross frames of the wagon, by iron wire and spacer blocks.

Except for this the load is free to adapt itself to any curves as the wagons move along. All couplings are taken up tight before loading begins, the wagons being attached in the rear of goods trains and all rough shunting prohibited.

Unloading.

Unloading is effected direct at the laying site. The simplest method consists in pulling the rails by the ends, one b
one, off the wagons by rope or chai
one end being secured to a web hole, th
other to the track, and the wagons bein
hauled slowly forward (fig. 18).

This method gives good results; it
recommended to have a small wagon wit
a sloping surface fixed on top, to follo
the wagon being unloaded in order
reduce the height the rail ends have
fall.

* * *

TESTS.

The Belgian National Railways Com
pany has had a large number of tes

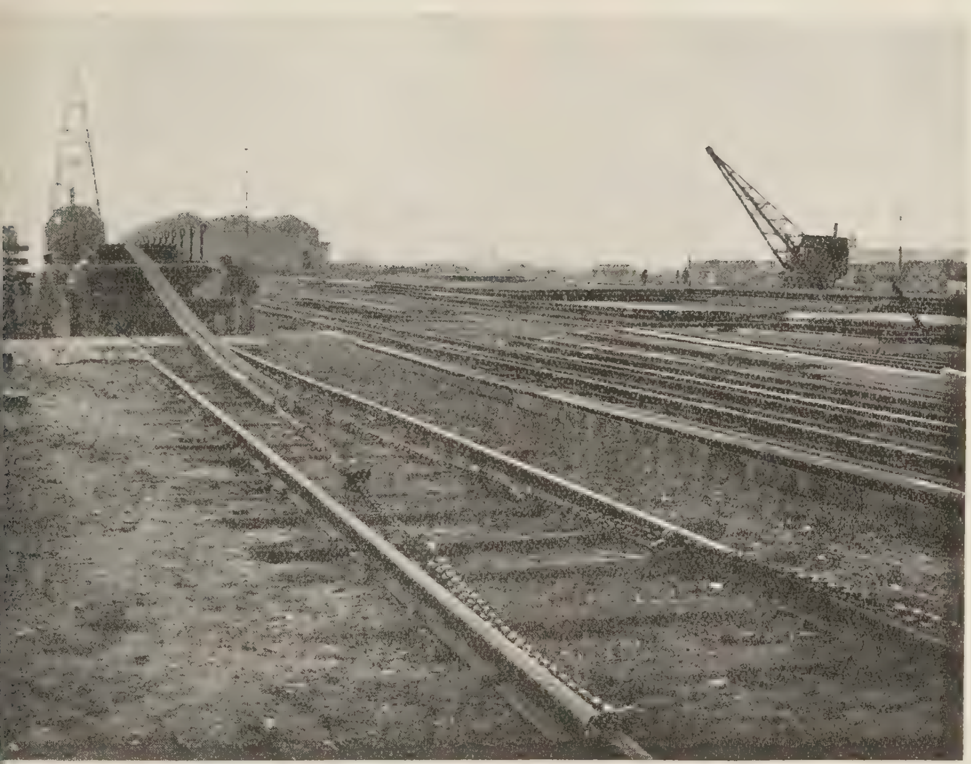


Fig. 18. — Unloading long rails on site.

rried out in order to compare the value
various types of rail welds and as-
rtain their strength relatively to that
solid rails. The most interesting of
ese are described below. Unless other-
ise stated, they were made on rails of
andard section, weighing 50 kgr. per
. (100.8 lb. per yard), the cross sec-
onal area being 6 700 mm² (12.8 sq.
.) (1).

I. — Surface hardness tests.

These were carried out on three pieces of rails welded respectively by the three methods described above.

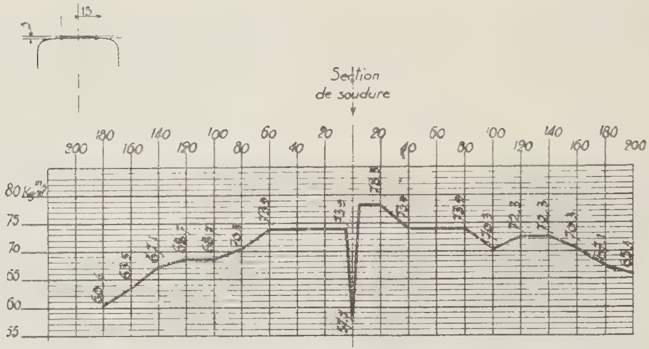
The graphs in figure 19 give hardness curves taken along a line on the upper planed surface of the rail head, 15 mm. (19/32") from the central longitudinal plane, with a Brinell machine having a 10 mm. (3/8") ball, subjected to a pressure of 3 000 kgr. (6 610 lb.) for 15 seconds.

These graphs show :

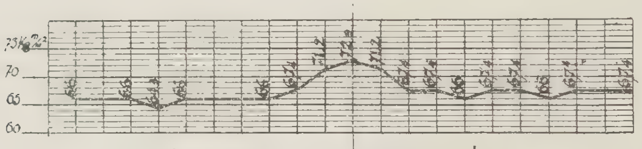
1. Very great uniformity of surface hardness in the vicinity of the joint welded by the resistance process, and then annealed. This surface hardness conduces to the preservation of an even running surface near the weld and con-

---

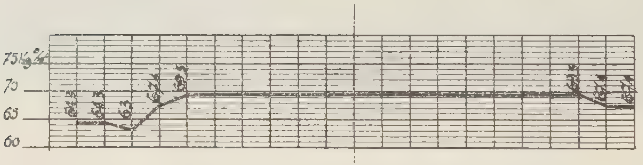
(1) The surface hardness, tensile, resilience
d impact tests as well as the micrographic
aminations, were carried out in the testing
oratory of the Company, at Malines, under
e supervision of Mr. J. Servais, head of the
rmanent way materials testing section.



Soudure aluminothermique, préchauffage et pression, recuite



Soudure par resistance electrique brute.



Soudure par résistance électrique, recuite

Fig. 19. — Brinell hardness curves.

Note: Section de soudure = Location of weld.
Top: Preheated and *annealed* thermit-pressure weld.
Middle: *Unannealed* resistance weld.
Bottom: *Annealed* resistance weld.

sequently reduces the fatigue on the joint in service.

2. An increase in the hardness of this area in the case of a similar joint, not heat treated.

3. A very irregular hardness curve in the case of the thermit weld. The sudden fall of hardness in the zone about the weld, as shown by the graph, is due to the presence of a soft metal plate inserted between the two rail ends in order to facilitate the welding process. This reduction in hardness may cause supplementary fatigue in service.

II. — Tensile and static bending tests

Tensile tests were carried out with a 50-ton Amsler machine on test pieces 13.8 mm. (69/128") diameter and 10 mm. (3 15/16") long.

Table 1 (page 462) gives the results of a few tests which show, compared with the normal metal of the rail, that:

1. There is a slight reduction in th

tensile strength with electric resistance welds, heat treated.

2. The opposite effect is found in the case of non-annealed resistance welds.

3. There is considerable reduction in the tensile strength with the thermit weld, due to the inserted soft metal plate, as well as appreciably lower figures for the elongation and contraction.

In addition, during the static bending tests, tensile measurements taken with Huggenberger extensometers, and deflection values taken with a fleximeter to the nearest 0.01 mm. (0.00039) gave, from graphic determination, the following figures for true elastic limit :

For a piece of ordinary rail : 33.62 kgr./mm^2 (21.44 Engl. tons/sq. in.);

For an electrical resistance weld, not annealed : 27.88 kgr./mm^2 (17.6 Engl. tons/sq. in.);

For a similar weld, annealed, 37.04 kgr./mm^2 (23.51 Engl. tons/sq. in).

III. — Metallographic examination.

Plates I to IV are micrographs made on the same side, starting from the weld, in various parts of rails welded by different methods (magnification = 100). They reveal some very interesting facts.

(a) Unannealed welds.

With the thermit process the presence of the soft metal plate inserted between rail heads is noticeable; with electric welding, on the other hand, the Widmanstaetten acicular, or needle, structure, is definitely observable, indicating an overheated condition approaching fusion. With both the thermit and resistance processes, a zone of coarse crystallisation is found in the immediate vicinity of the weld, due to overheating; this zone, which is necessarily of considerable fragility, is only about half the size with electric welding than with the other process.

The overheated zone is followed by one having an annealed character, of fine, close grain, denoting that even the rail metal itself has undergone an improvement in this part, serving as a transition to the ordinary structure as rolled.

(b) Heat-treated welds.

The micrographs show that the rudimentary heat treatment, as carried out at the site with the thermit welds by small burner-heated muffles, is very imperfect and effects scarcely any restoration of the metal; consequently brittleness subsists in the welded zone.

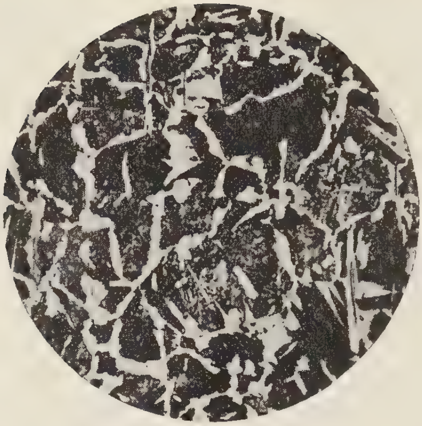
On the other hand, annealing carried out in the shop, in a furnace with controlled temperatures, normalises the grain of the steel and makes it finer over a distance of some 400 mm. (16") comprising the whole zone. The Widmanstaetten structure completely disappears, leaving only, in the immediate vicinity of the weld, a small zone of somewhat coarse and reticular crystallisation. The brittleness created by the overheating is thereby greatly diminished.

IV. — Resilience tests.

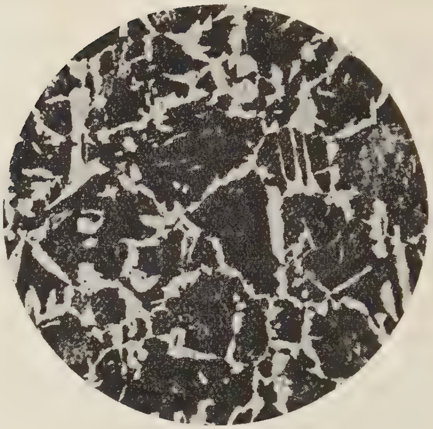
The extent of the alteration to the rail metal in the welded zone was investigated by a number of resilience tests carried out on Mesnager 10 × 10 × 55-mm. (3/8" × 3/8" × 2 3/16") test pieces with a 2-mm. (5/64") notch rounded at the bottom, by means of a 30-kgr. (66 lb.) Charpy pendulum.

Some of the most interesting results are given in table II.

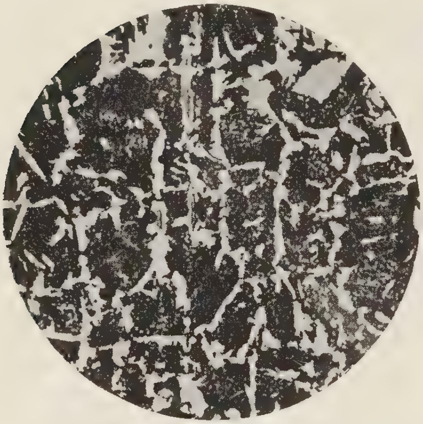
Plate I. — **Preheated th**



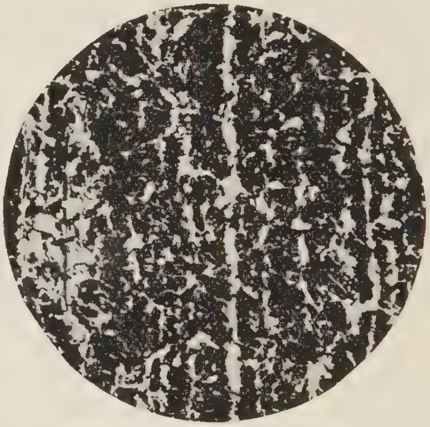
150 mm. (6") from weld.



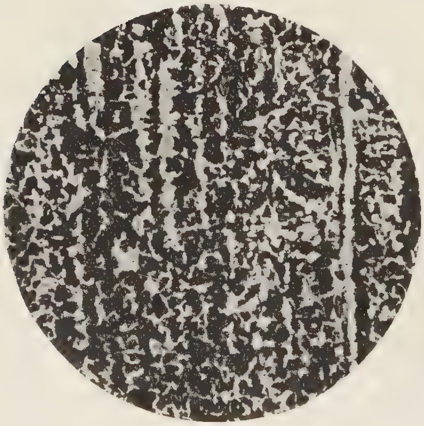
85 mm. (3 3/8") from weld.



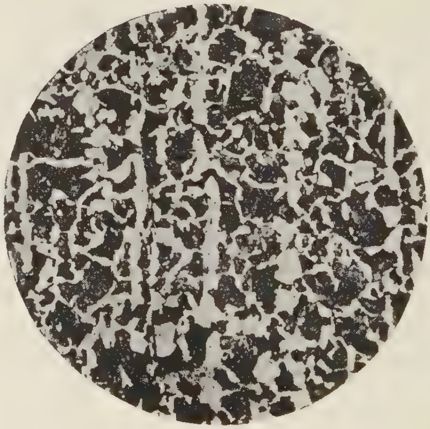
70 mm. (2 3/4") from weld.



65 mm. (2 9/16") from weld.

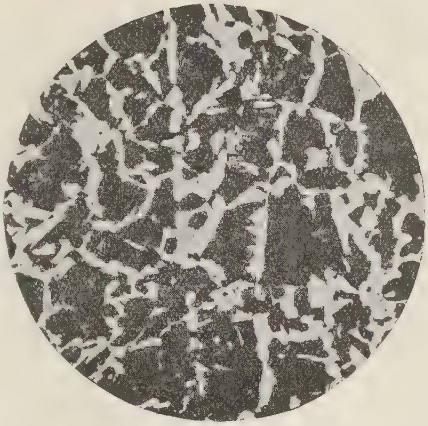


55 mm. (2 3/16") from weld.

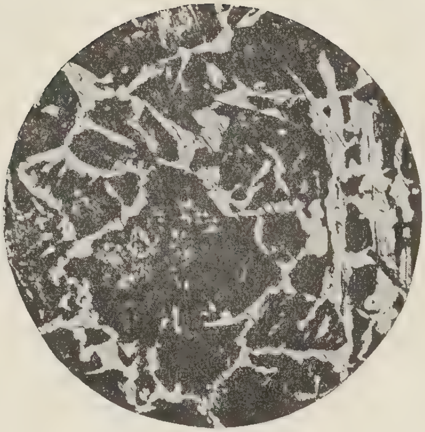


45 mm. (1 3/4") from weld.

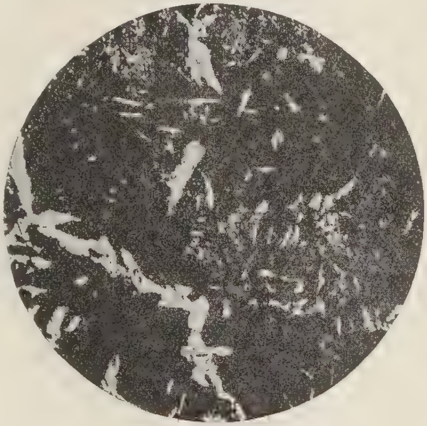
sure-weld. — Unannealed.



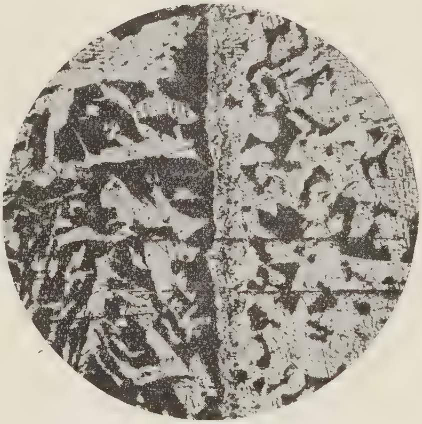
40 mm. (1 9/16") from weld.



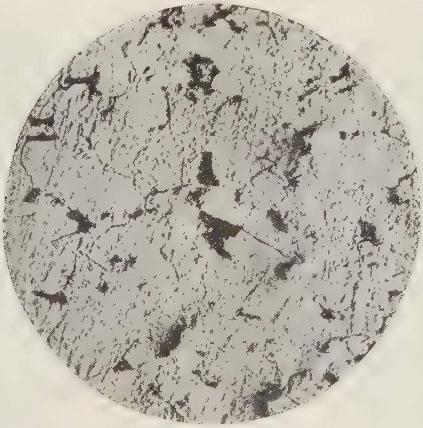
28 mm. (1 1/8") from weld.



Zone adjacent to weld.

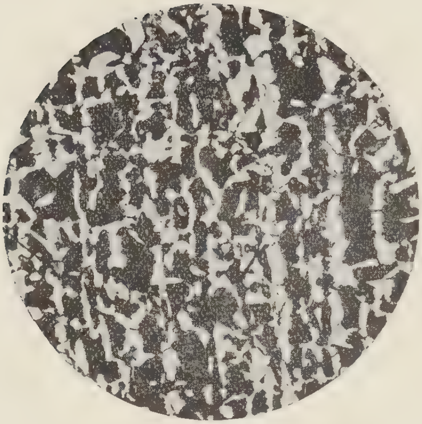


Through both the mild steel plate
and the rail metal.

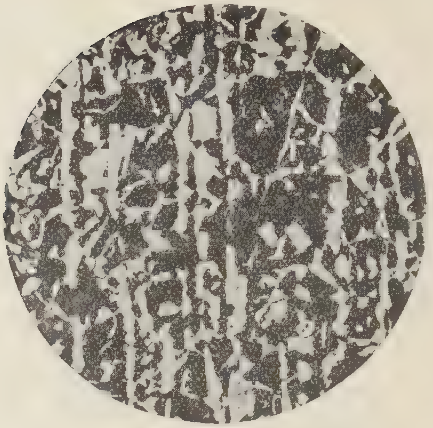


Metal of the plate inserted in the
centre of the weld.

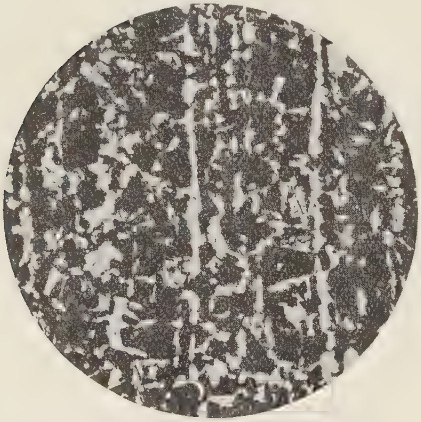
Plate II. — **Preheated ther**



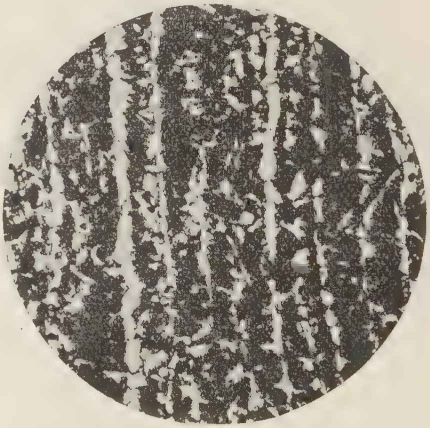
150 mm. (6") from weld.



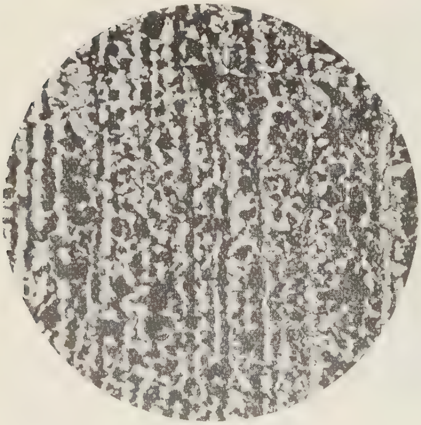
130 mm. (5 1/8") from weld.



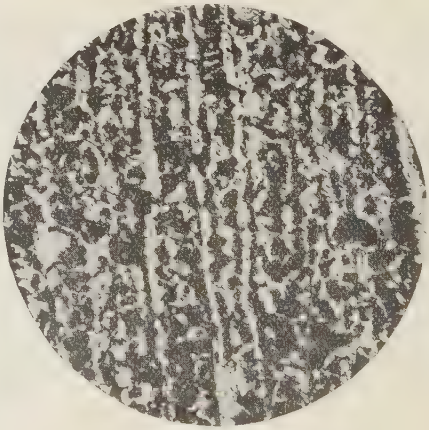
115 mm. (4 1/2") from weld.



110 mm. (4 3/8") from weld.

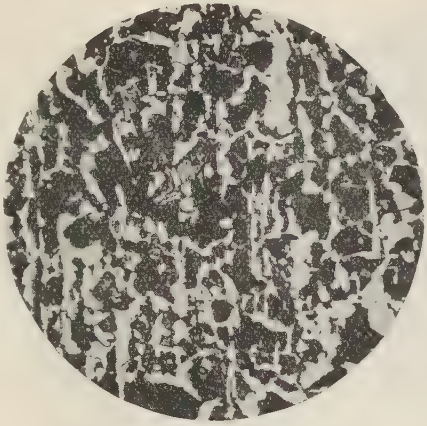


105 mm. (4 1/8") from weld.

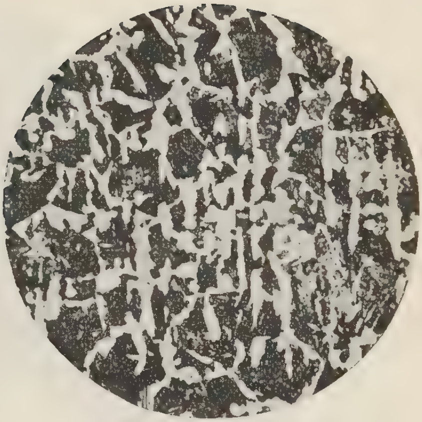


95 mm. (3 3/4") from weld.

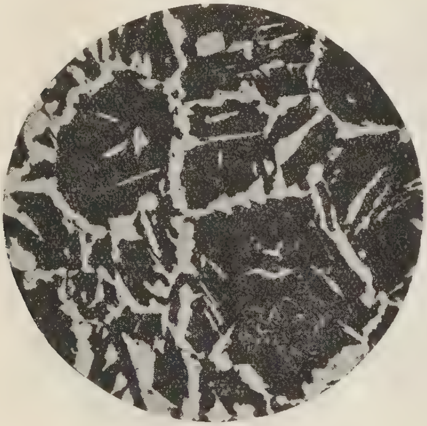
ure-weld. — Annealed.



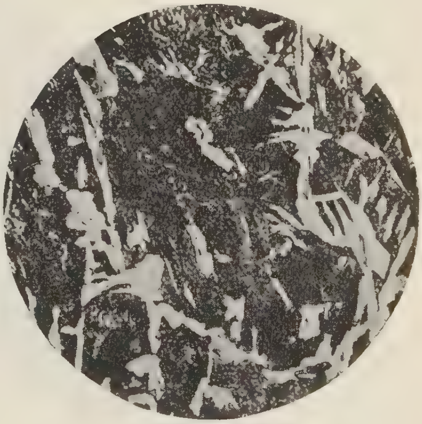
80 mm. (3 5/32") from weld.



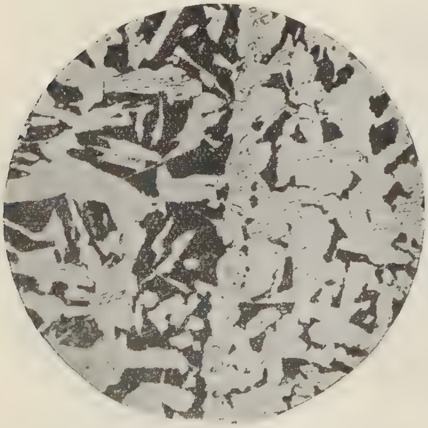
60 mm. (2 3/8") from weld.



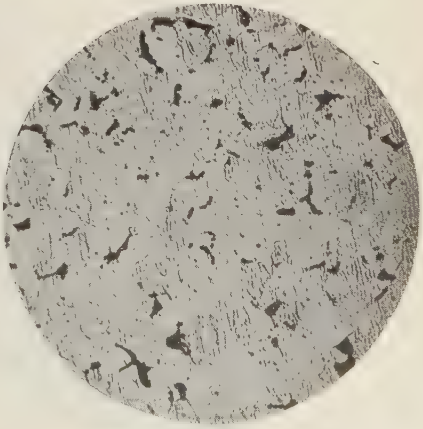
35 mm. (1 3/8") from weld.



Zone adjacent to weld.

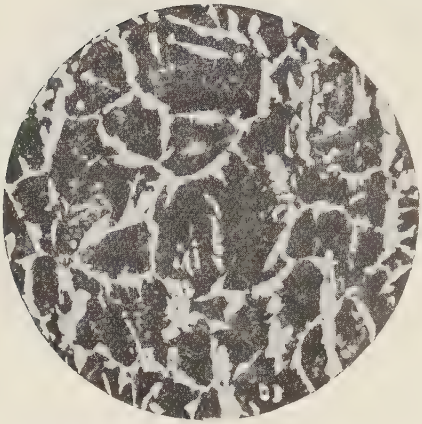


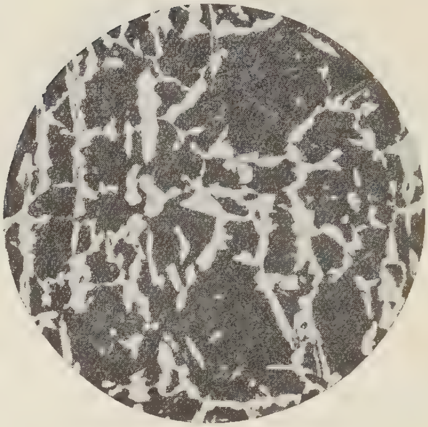
Through both the mild steel plate and the rail metal.

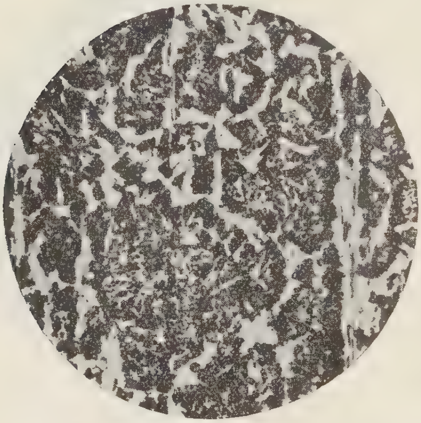


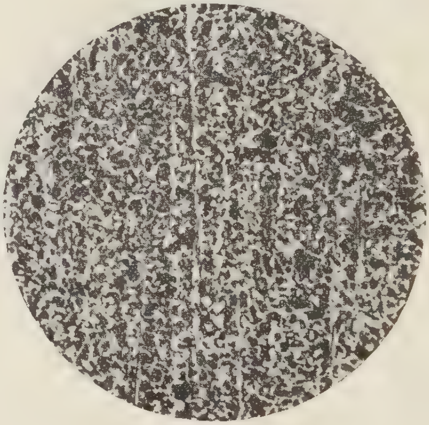
Metal of the plate inserted in the centre of the weld.

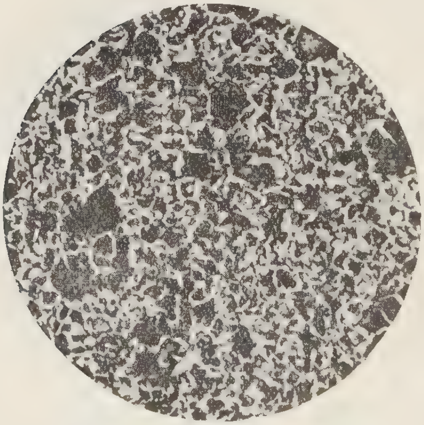
Plate III. —[Electric resis

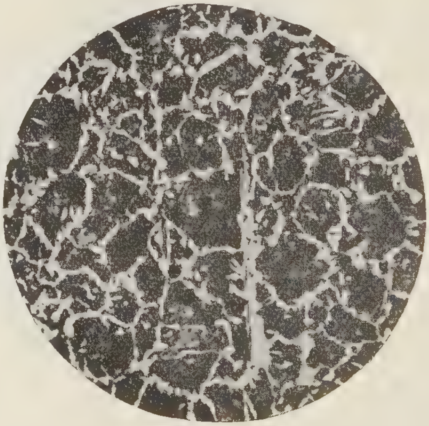

70 mm. (2 3/4") from weld.


45 mm. (1 3/4") from weld.

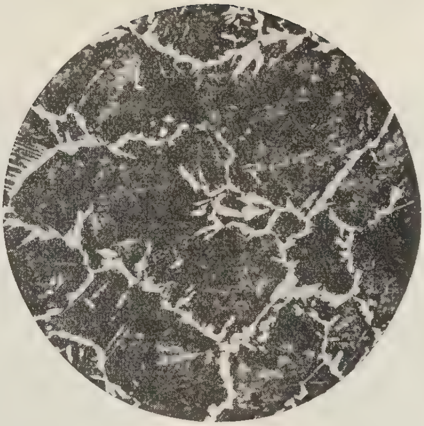

40 mm. (1 9/16") from weld.


35 mm. (1 3/8") from weld.

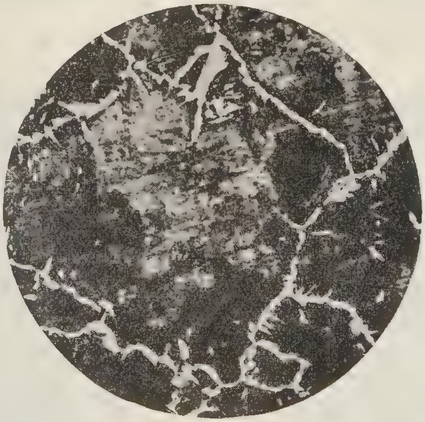

30 mm. (1 3/16") from weld.


20 mm. (25/32") from weld.

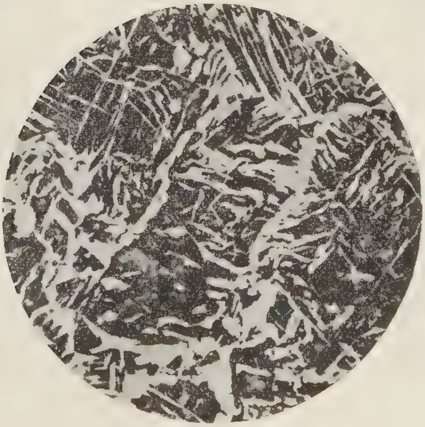
h-butt) weld. — Unannealed.



10 mm. (25/64") from weld.

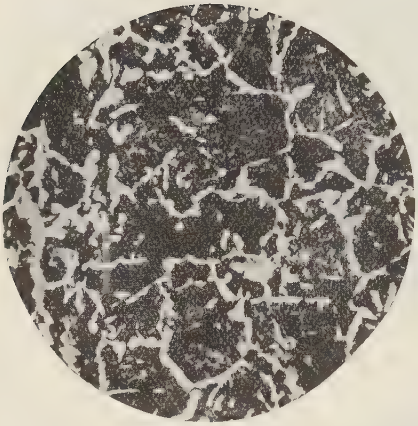


3 mm. (1/8") from weld.

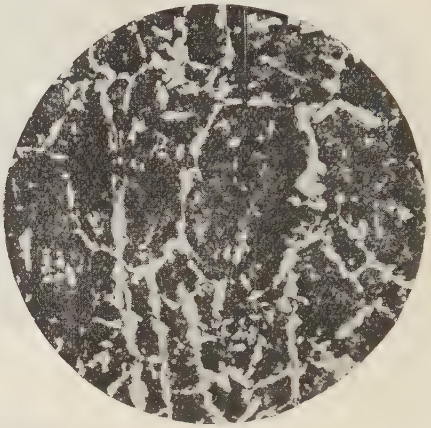


Through centre of weld.

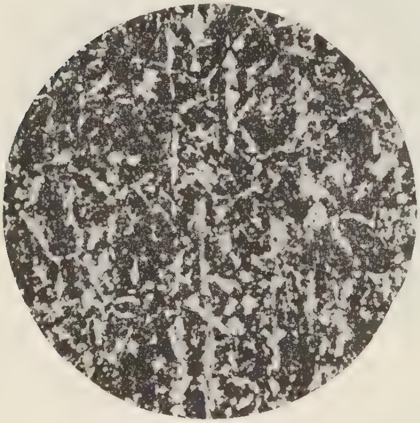
PLATE IV. — **Electric resista**



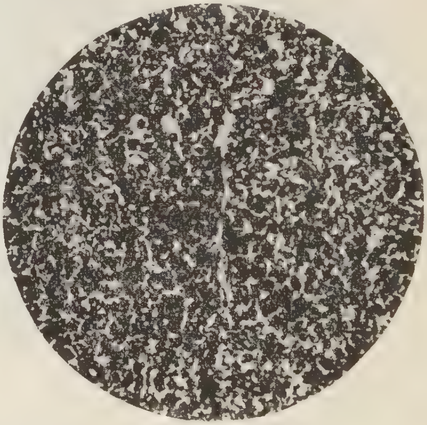
200 mm. (7 7/8") from weld.



155 mm. (6 1/8") from weld.



150 mm. (6") from weld.



130 mm. (5 1/8") from weld.

For all classes of welds it is found that :

1. There is a noteworthy improvement in the quality of the rail metal in zones B and B_1, where during welding the metal has taken on an annealed structure.

2. There is a diminution of resilience in the actual weld itself, varying with the process used.

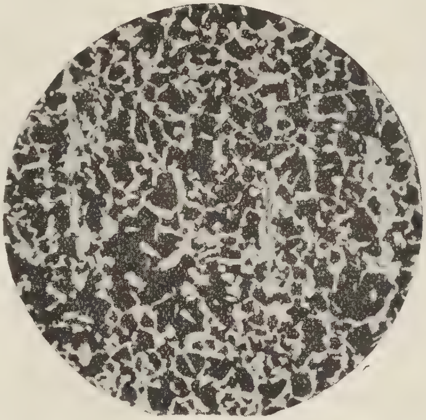
Compared with mean resilience values obtained for portions of the normal structure of the steel, these diminutions were of about :

17 % for resistance welds, annealed, 69 % for the same welds, not annealed.

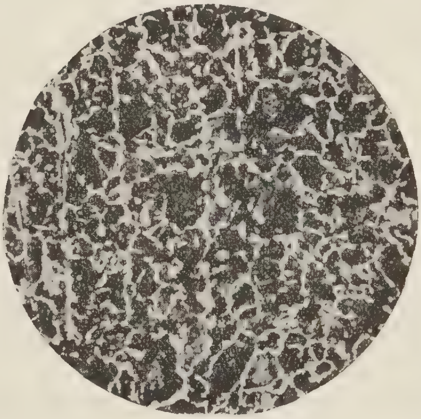
62 % for thermit-pressure welds, with pre-heating and subsequent annealing.

The annealing of electric welds, car-

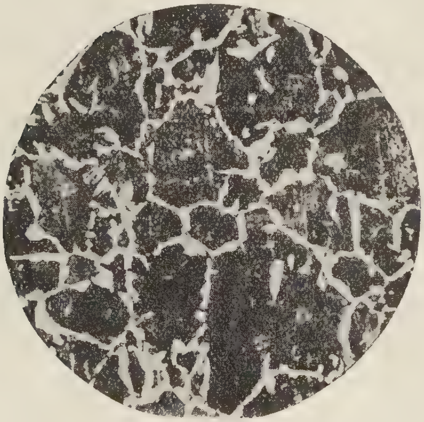
-butt) weld. — Annealed.



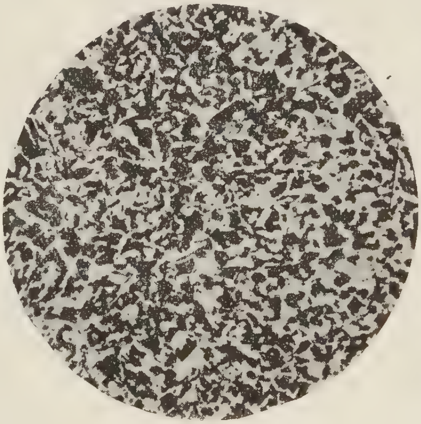
90 mm. (3 1/2") from weld.



45 mm. (1 3/4") from weld.



10 mm. (25/64") from weld.



Through centre of weld.

ried out under satisfactorily controlled conditions, considerably improves the quality of the plain weld; on the other hand, the rudimentary annealing of the thermit weld merely produces an insignificant improvement in the brittleness figure; the mean value given is even falsified by the presence, at the notch in the Mesnager test pieces, of the soft metal plate inserted between the rail ends.

V. — Impact tests.

Tables III and V give the results of a series of impact tests made on resistance welded pieces, annealed and not annealed.

Test conditions.

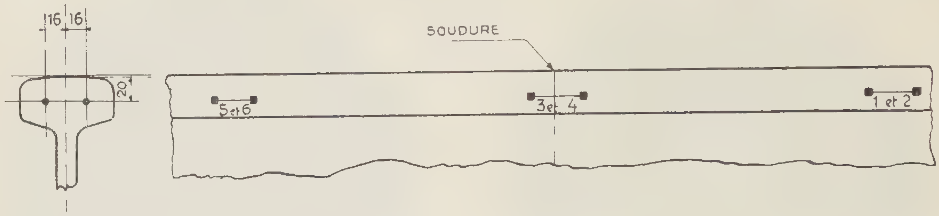
Distance between supports : 1.10 m. (3' 7 5/16").

Weight of tup : 500 kgr. (1 100 lb.).

Height of drop : 4 m. (13' 1 1/2").

Head and foot of rail alternately in tension.

TABLE 1.



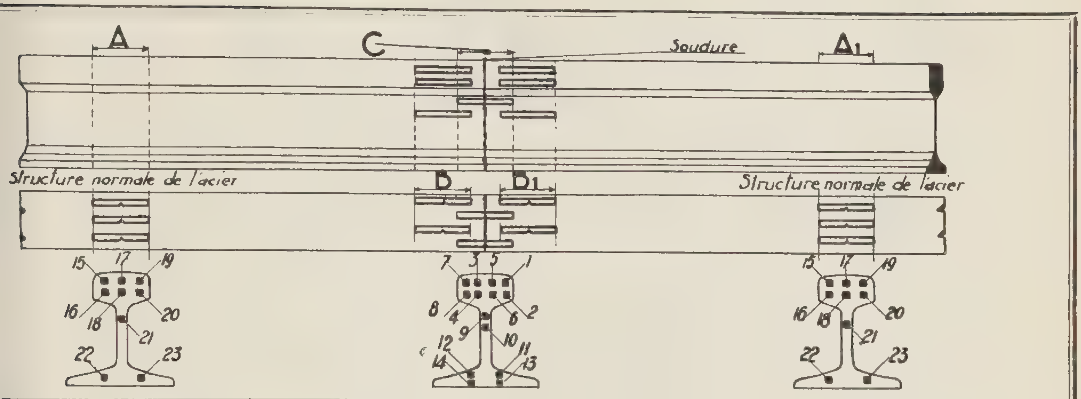
Serial number of test pieces.	ELONGATION, %.			CONTRACTION, %.			BREAKING LOAD, kgr./mm² *(Engl. t./sq. in.)*.		
	× I	+ II	○ III	× I	+ II	○ III	× I	+ II	○ III
1	2.15	18.5	19.5	46.4	45.3	48.5	64.8 *(41.1)*	68.2 *(43.3)*	69.6 *(44.2)*
2	7.0	18.5	20.0	7.0	45.3	48.5	59.5 *(37.8)*	68.2 *(43.3)*	69.6 *(44.2)*
3	6.5	14.0	15.5	25.6	43.2	44.2	54.3 *(34.5)*	69.5 *(44.1)*	68.1 *(43.2)*
4	5.0	13.0	16.5	17.9	42.1	44.2	51.5 *(32.7)*	69.3 *(44.0)*	68.8 *(43.7)*
5	18.0	18.5	18.0	43.5	41.0	41.0	69.3 *(44.0)*	68.8 *(43.7)*	75.0 *(47.6)*
6	21.5	18.0	17.5	44.3	52.6	41.0	70.3 *(44.6)*	69.2 *(43.9)*	75.0 *(47.6)*
							Breakage of test pieces 3 - 4, within the weld.	Breakage of test pieces 3 - 4, outside the weld.	Breakage of test pieces 3 - 4, outside the weld.

× I = Annealed thermit-pressure weld, with preheating, of 52 kgr./m. (104.8 lb. per yard) Belgian State used rails.

+ II = Unannealed resistance (flash-butt) weld.

○ III = Annealed resistance (flash-butt) weld.

TABLE II.



Resilience, kgrm./cm² *(ft.-lb./sq. in.)* Resistance weld, annealed.					Resilience, kgrm./cm² *(ft.-lb./sq. in.)* Resistance weld, unannealed.					Resilience, kgrm./cm² *(ft.-lb./sq. in.)* Thermit-pressure weld, annealed, and with preheating.				
Series.					Series.					Series.				
A	B	C	B_1	A_1	A	B	C	B_1	A_1	A	B	C	B_1	A_1
...	...	0.926	...	...	...	...	1.676	...	...	...	...	...	...	...
...	...	3.405	...	...	...	. .	1.676	...	...	...	...	1.875	...	...
...	...	4.127	...	...	...	...	0.926	...	...	...	...	1 481	...	...
...	...	3.405	...	...	...	...	1.290	...	...	...	...	1.676	...	...
...	4.900	...	2.554	...	...	4.376	...	5.148	...	...	...	1.481	...	...
...	5.148	...	4.630	...	...	5.660	...	4.630	...	...	...	...	...	...
...	4.127	...	1.481	...	...	4.630	...	4.630	...	...	...	...	...	...
...	4.127	...	3.405	...	...	5.148	...	4.900	...	...	..	...	...	...
...	...	4.376	...	...	...	...	0.752	...	...	...	...	1.290	...	...
..	17.455	...	3.880	...	...	18.705	...	5.410	...	...	...	...	...	...
...	...	4.376	...	...	...	...	0.926	...	...	...	...	1 481	...	...
...	...	4.900	...	...	...	...	1.106	...	...	...	...	1.106	...	...
. .	5.148	...	3.880	...	...	2.720	...	5.148	...	. .	...	...	...	...
...	5.410	...	3.640	...	...	4.127	...	3.880	...	...	...	...	...	...
4.376	...	...	...	1.875	3.405	...	...	...	3.640	4.127	...	...	...	2.720
4.900	...	...	...	1.106	2.290	...	...	...	3.172	4.376	...	...	...	4.127
3.172	...	..	...	1.481	1.290	...	...	...	3.172	5.410	. .	...	...	4.127
5.955	...	...	...	1.290	2.720	...	...	...	4.376	2.720	...	...	...	2.503
4.900	...	...	...	2.720	1.875	...	...	...	3.172	4.376	...	...	...	2.720
4.376	..	...	...	0.943	1.875	...	...	...	3.640	1.676	...	...	...	3.880
19.511	...	...	...	5.953	11.720	...	...	...	4.900	6.520	...	...	...	3.880
5.200	...	...	...	3.640	4.376	...	...	...	4.900	4.127	...	...	...	3.880
5.955	...	...	...	3.405	4.170	...	...	...	4.376	4.900	...	...	...	3.640
6.483 *(302)*	6.616 *(309)*	3.645 *(170)*	3.339 *(156)*	2.490 *(116)*	3.747 *(175)*	5.626 *(263)*	1.193 *(55.6)*	4.820 *(225)*	3.927 *(183)*	4.248 *(198)*	...	1.484 *(69.2)*	...	3.497 *(163)*

tructure normale de l'acier = normal structure of the steel. — 1 kgrm./cm² = 46.66 ft.-lb./sq. in.

Comparison of the two tables brings out very clearly the restoring effect of annealing, and also confirms the results given by the micrographs. The diminution in the brittleness of the annealed welds is truly remarkable. They always stand up to at least 6 blows of the tup, with rail head and foot alternately in tension and compression.

It should be pointed out, in this connection, that the mean impact test figure for *unannealed* resistance welds (4 blows of the tup before breaking) was never obtained with the other methods of welding. As a matter of comparison, it may be mentioned that the Company's specification for new rails calls for an impact test on the crop ends from all ingots in a cast.

Height of fall of tup :
(1) 4 m. (13' 1 1/2") for 94 % of the test pieces;
(2) 6 m. (19' 8 1/4") for the remainder;
Weight of tup : 1 000 kgr. (2 200 lb.).
Distance between supports : 1.10 m. (3' 7 5/16").

VI. — Fatigue tests by repeated bending.

Among the practical tests to which rail welds can be usefully submitted one of the most interesting appears to be that of fatigue by repeated bending, as it best reproduces service conditions.

Such tests have been carried out with an Amsler machine (pulsator) developing a static force of 100 tons, at the laboratory for testing materials, of Liége University, under the direction of Professor F. Campus (fig. 20).

Test conditions.

Vibrations of variable intensity applied periodically across the whole width of the rail foot of a welded joint, located in the centre of a piece of rail carried on cylindrical supports placed 0.90 m. (2' 11 1/2") apart.

Minimum load : 5 tons.

Frequency : 250 pulsations per minute for the heavy loads (45 tons and over).

500 per minute for lesser loads.

Maximum calculated stress in the heads of the rails for a load P : 0.82 P kgr./mm^2.

The results of numerous trials are seen in the diagram, figure 21, as Wöhler curves plotted as semi-logarithmic co-ordinates.

The power of the machine was such as to allow of the fatigue curve being drawn for plain rail, by way of comparison.

Figure 21 brings out in particular :

1. An important dispersion of the

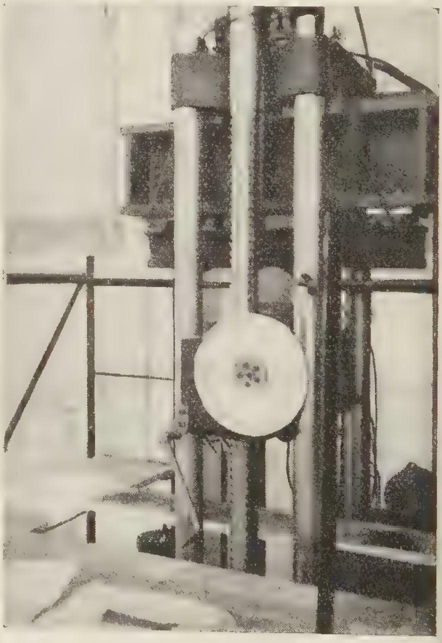
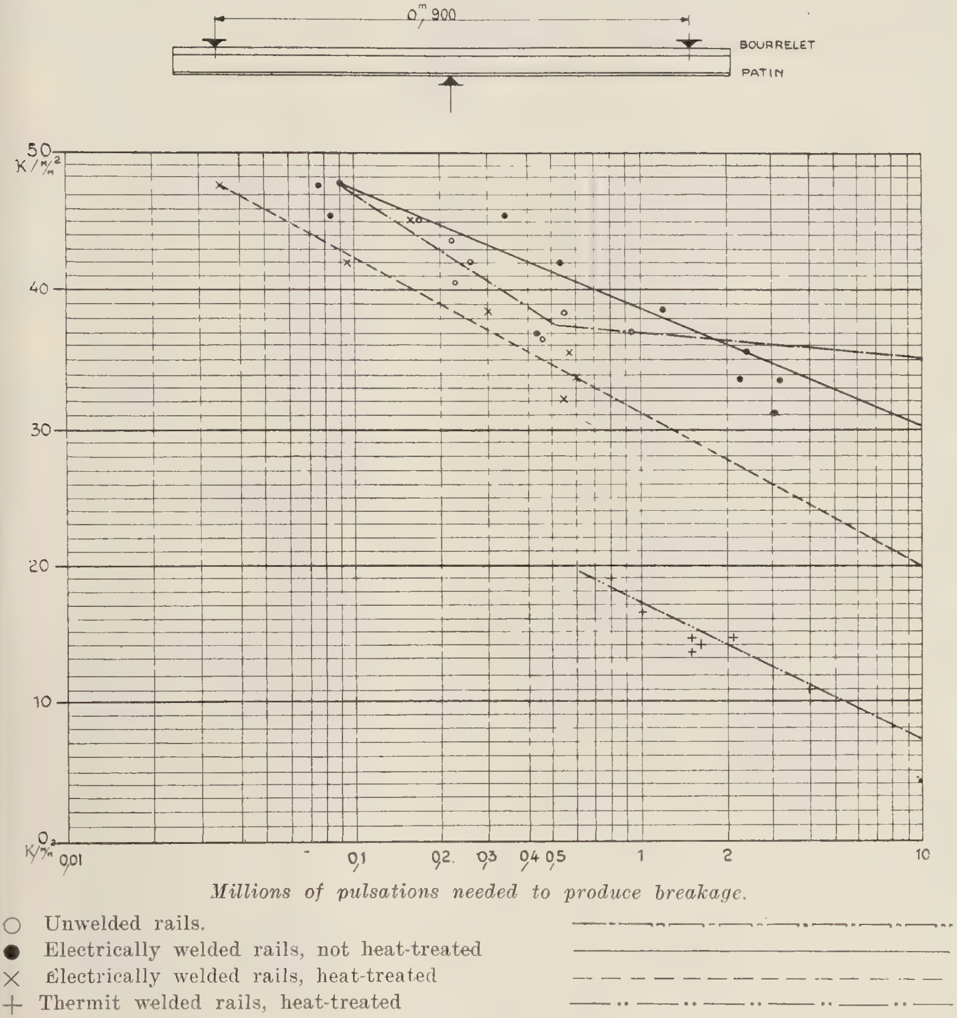


Fig. 20. — Amsler 100-ton fatigue testing machine.

Fatigue tests by repeated bending.



Note: Bourrelet = head. — Patin = foot.

Fig. 21.

oints of breakage in untreated electric sistance welds, as a consequence of the teration in the metal in the vicinity of e welding zone.

2. A greater resistance to fatigue in an nannealed resistance weld than in an annealed resistance weld; this agrees with the results of the tensile and hardness tests given above, because a greater tensile strength in a material is normally accompanied by greater resistance to fatigue.

TABLE III.

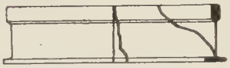
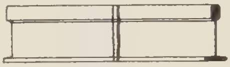
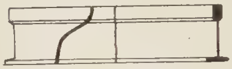
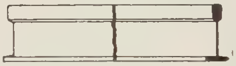
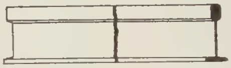
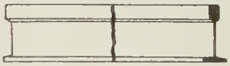
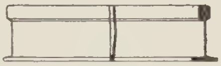
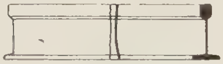
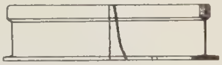
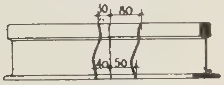
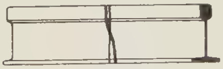
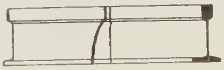
Serial number of test.	Number of successive blows.	Deflections recorded, mm. *(inches)*.	Position of rail on supports.	Remarks.
Electric resistance weld, UNANNEALED.				
1	1st	broken	⊥	 Breakage in rail head : Coarse grain.
2	1st	16 (5/8")	⊥	 Breakage along weld : Coarse grain in web and foot, rather fine in head.
	2nd	29 (1 9/64")	⊥	
	3rd	6 (1/4") H.	⊤	
	4th	11 (7/16") F.	⊤	
	5th	broken	⊤	
3	1st	broken	⊥	 Breakage in head : Somewhat coarse grain.
4	1st	17 (43/64")	⊥	 Breakage along weld : Coarse grain.
	2nd	33 (1 19/64")	⊥	
	3rd	broken	⊤	
5	1st	18 (23/32")	⊥	 Breakage along weld : Coarse grain.
	2nd	34 (1 3/8")	⊥	
	3rd	8 (5/16") H.	⊤	
	4th	10 (25/64") F.	⊤	
	5th	24 (15/16") F.	⊤	
	6th	broken	⊥	
6	1st	18 (23/32")	⊥	 Breakage along weld : Coarse grain.
	2nd	33 (1 19/64")	⊥	
	3rd	8 (5/16") H.	⊤	
	4th	9 (23/64") F.	⊤	
	5th	22 (7/8") F.	⊤	
	6th	2 (5/64") H.	⊥	*Note.* ⊥ = rail resting on its foot. ⊤ = rail resting on its head.
	7th	broken	⊥	

TABLE IV.

Serial number of test.	Number of successive blows.	Deflections recorded, mm. *(inches)*.	Position of rail on supports.	REMARKS.
		Electric resistance weld, ANNEALED.		
1	1st	20 (25/32")	⊥	 Breakage alongside the weld. Fine grain and jagged edges.
	2nd	36 (1 7/16")	⊥	
	3rd	11 (7/16") H	⊤	
	4th	6 (1/4") F	⊤	
	5th	20 (25/32") F	⊤	
	6th	5 (13/64") H	⊥	
	7th	broken	⊥	
2	1st	19 (3/4")	⊥	 Breakage with jagged edges : Fine grain.
	2nd	35 (1 3/8")	⊥	
	3rd	9 (23/64") H	⊤	
	4th	9 (23/64") F	⊤	
	5th	24 (15/16") F	⊤	
	6th	4 (5/32") H	⊥	
	7th	19 (3/4") H	⊥	
	8th	7 (9/32") F	⊤	
	9th	20 (25/32") F	⊤	
	10th	broken	⊥	
3	1st	17 (43/64")	⊥	 Breakage with jagged edges : Fine grain.
	2nd	32 (1 1/4")	⊥	
	3rd	8 (5/16") H	⊤	
	4th	9 (23/64") F	⊤	
	5th	19 (3/4") F	⊤	
	6th	broken	⊥	
4	1st	19 (3/4")	⊥	 Breakage with jagged edges : Fine grain.
	2nd	36 (1 7/16")	⊥	
	3rd	12 (15/32") H	⊤	
	4th	7 (9/32") F	⊤	
	5th	18 (23/32") F	⊤	
	6th	broken	⊥	
5	1st	19 (3/4")	⊥	 Breakage with jagged edges : Fine grain.
	2nd	36 (1 7/16")	⊥	
	3rd	10 (25/64") H	⊤	
	4th	9 (23/64") F	⊤	
	5th	25 (1") F	⊤	
	6th	3 (1/8") H	⊥	
	7th	20 (25/32") H	⊥	
	8th	7 (9/32") F	⊤	
	9th	23 (29/32") F	⊤	
	10th	5 (13/64") H	⊥	
	11th	22 (7/8") H	⊥	
	12th	6 (1/4") F	⊤	
	13th	22 (7/8") F	⊤	
	14th	7 (9/32") H	⊥	
	15th	broken	⊥	
6	1st	20 (25/32")	⊥	 Breakage with jagged edges : Fine grain.
	2nd	37 (1 29/64")	⊤	
	3rd	11 (7/16") H	⊤	
	4th	8 (5/16") F	⊤	
	5th	24 (15/16") F	⊤	
	6th	3 (1/8") H	⊥	
	7th	19 (3/4") H	⊥	
	8th	6 (1/4") F	⊤	
	9th	18 (23/32") F	⊤	
	10th	broken	⊥	

3. Considerable superiority of the resistance welds over those made by other processes.

Relatively to the fatigue resistance of an ordinary rail, taken as unity, the diagram in figure 21 gives by extrapolation of the Wöhler curves and for a number of pulsations = 10^7, corresponding approximately to the total bending stress undergone by a rail during its life in a running road of the Company, as will be shown below, relative approximate figures for the various types of welded joints, as follows :

Unannealed resistance weld : 0.85.

Annealed resistance weld : 0.57.

Annealed thermit-pressure weld, with pre-heating : 0.23.

SAFETY OF WELDED RAILS IN THE RUNNING ROADS.

General considerations.

It appeared desirable to ascertain what degree of safety could be counted on at the present time for welded joints in main lines traversed by expresses.

The impact and fatigue tests described above furnish useful indications in this respect on condition that the approximate value of the actual maximum stresses to which rails may be subjected in service be known.

To arrive at this value, theories have been advanced, from which more or less complicated formulæ have been developed; it cannot, however, be denied that in a phenomenon so complicated as that of the stresses in rails in service, dependent on a number of variable factors (nature of the sleepers, ballast and roadbed; rail fastenings and their efficiency; rail sections; variations of surrounding temperature; composition of trains; speed, etc.), only somewhat vague results relating to a relatively restricted number of cases can be obtained theoretically; more or less exact data can only be obtained experimentally, by direct measurement. Some Railways have now entered upon this course, and some very interesting particulars will doubtless be available shortly.

Among the various stresses, regular or occasional, affecting the cross section of properly laid rails we may mention :

(a) The effect produced by a flat on a wheel.

Such stress is, it is true, an exceptional one when rolling stock is properly maintained, but safety considerations require that it shall be taken into account; violent blows result from it with the present axle loads and speeds, and absolute freedom from brittle zones in the rails is essential.

The impact tests and micrographic examinations described above show that only the annealed resistance weld meets the case.

(b) The constraint effects produced by variations of surrounding temperature and, at times, those caused by braking efforts and acceleration. They set up compression and tensile stresses, varying with the temperature changes, the length of the rails, the manner in which the latter are fastened to the sleepers, and the extent to which the sleepers are encased in the ballast.

Certain experiments made on the Belgian railway system, which were made the subject of a communication to the Paris Session of the International Railway Congress in 1937 (1) showed that, in certain circumstances, constraining forces of the order of 6 kgr./mm² (3.81 Engl. tons/sq. in.) can be met with in the rails.

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(1) See Report on Question 1, by C. LEMAIRE, Chief of the Permanent Way Department, Belgian National Railways : *(Bulletin of the International Railway Congress Association*, February 1937).

(c) The effect of the passage of rolling loads. Direct measurements of the stresses in the rails have recently been made on the Belgian lines in collaboration with the « Faculté technique du Hainaut » under the direction of Professor Gysen. Unfortunately there were not many.

The dynamic extensometer of the « Deutsche Versuchsanstalt für Luftfahrt » (German Aviation Experimental Station) (fig. 22) was used. Its leading qualities are : absolute indeformability, efficiency unaffected by vibrations, great lightness (total weight 230 gr. (1/2 lb.) and so unaffected by inertia effects; direct registration of deformations without the interposition of articulated mechanism liable to play.

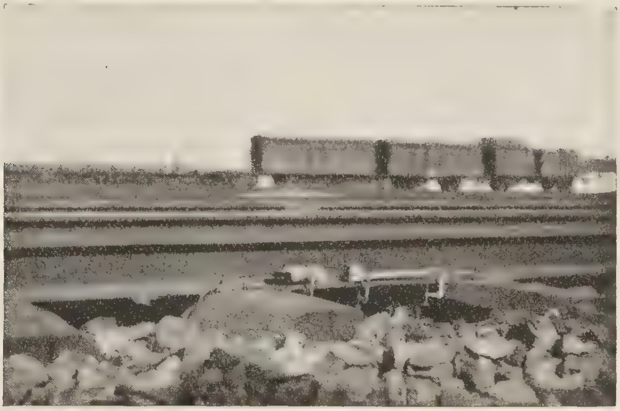


Fig. 22. — Dynamic extensometer attached to a rail foot.

Description of the dynamic extensometer.

(a) A case containing the recording mechanism and fitted with two fixed points, forming one of the limits of the part of the rail to be subjected to measurements, serving to secure the apparatus to the said part.

(b) An external tube, made perfectly true and forming an extension of the case, in which slides an interior tube carrying a second pair of points, marking the other limit of the part to be examined. The end of the interior tube near the case is terminated by a ball maintained between springs, which ball carries a marking diamond by means of a rod. This diamond, which is solid with the moveable points, thus describes the same path as these points when deformations of the part under investigation occur, and marks the displacements in natural size on a glass cylinder of some 8 cm (3 1/8"), fixed on a rotating drum, the axis of rotation of which is parallel to the axes of the two tubes.

(c) A small electric motor, with gearbox, driving the drum through an elastic coupling and worm; the drum has a friction clutch releasing automatically after one complete revolution, which the gear-

box of the motor allows of being completed in 1, 2 or 5 minutes as desired. While the device is working a fine diamond traces a reference line.

The deformations registered on the glass cylinder can be read by means of a microscope, with micrometer eye-piece and vertical illumination, and be photographed with any desired magnification (fig. 23).

Results of measurements.

Stress measurements have been recorded with this extensometer on standard section 50-kgr./m. (100.8 lb. per yard) rails laid on variously spaced wooden sleepers, while trains of four types composed as shown in figure 24 ran over them at different speeds; the apparatus was fixed on the rail foot near the outer edge.

The table in figure 24 shows the maximum stresses in the rail steel recorded in each case. The tests show that the stresses developed as the trains pass, of about 6 kgr./mm² (3.8 Engl. tons/sq. in.), are little affected by the speed, contrary to what might be thought at first sight, but as only a small number of tests were made, no certain conclusions can be drawn therefrom.

CONCLUSIONS.

The value of the maximum stresses to which the rails on the heavily worked lines in Belgium are submitted is consequently about 12 kgr./mm² (7.6 Engl. tons/sq. in.). Now, systematic measurements made on the Belgian main lines show that the rail heads undergo a vertical wear of some 0.1 mm. (0.0039") per annum under a daily traffic of 10 000 tons, corresponding to the passage of an average of 700 pairs of wheels.

On the other hand, the permissible limit of wear allowed by the regulations for the heads of rails in running roads of very important main lines is 4 mm (0.1575"). Renewal takes place after the passage of about 700 × 360 × 40 =

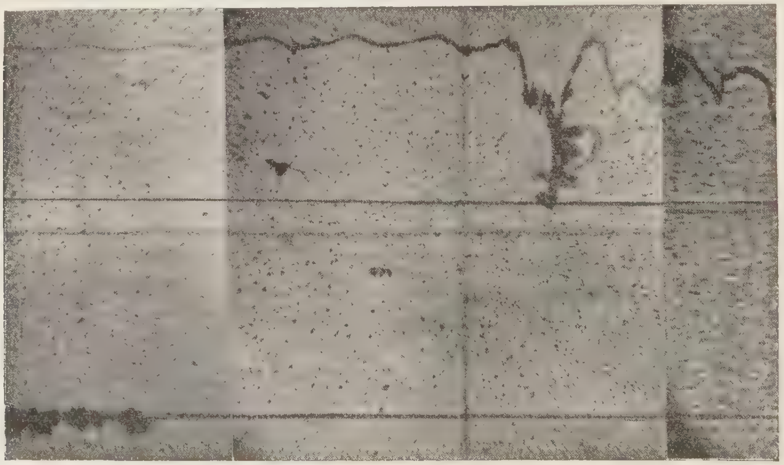
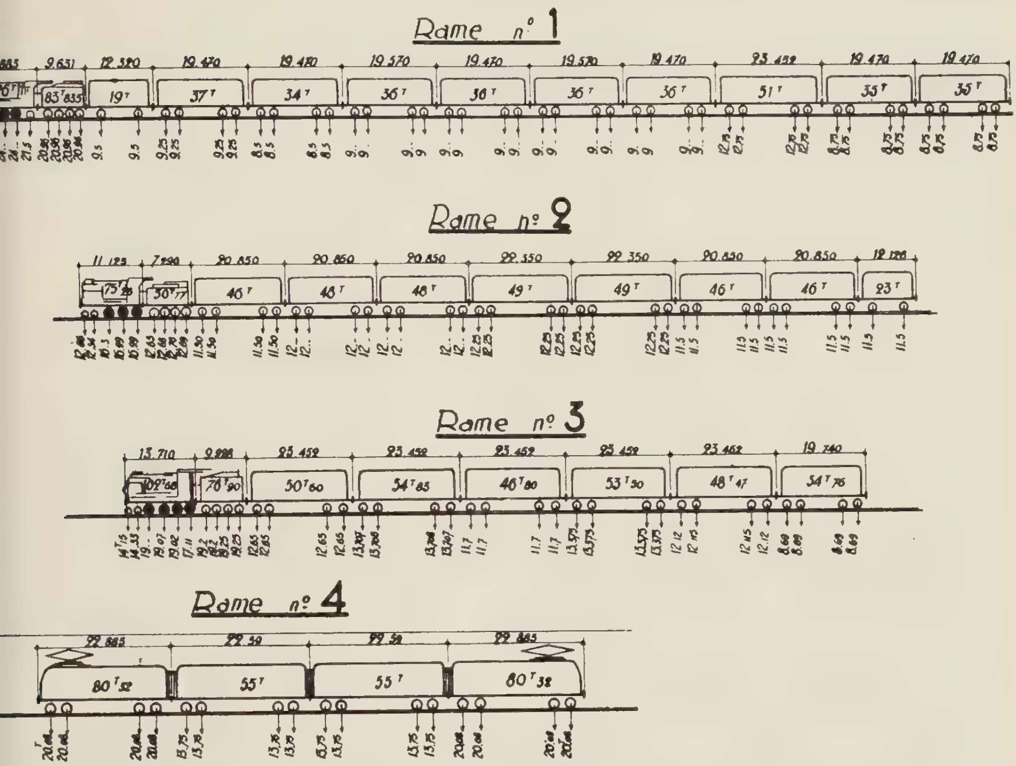


Fig. 23. — Enlarged photograph, showing deformations of rail foot, recorded by the dynamic extensometer.



rain umber.	Distance between sleeper centre lines.	Hourly train speed.	Maximum stress in rail foot.
1	62 cm. *(24 3/8")*	35 km. *(21.7 miles)*	6.5 kgr./mm² *(4.13 Engl. t./sq. in.)*
2	67 cm. *(26 3/8")*	91 km. *(56.5 miles)*	6.0 kgr./mm² *(3.80 Engl. t./sq. in.)*
3	67 cm. *(26 3/8")*	115 km. *(71.5 miles)*	5.3 kgr./mm² *(3.36 Engl. t./sq. in.)*
4	55.5 cm. *(21 3/4")*	70 km. *(43.5 miles)*	3.6 kgr./mm² *(2.28 Engl. t./sq. in.)*
	85 cm. *(33 1/2")*	70 km. *(43.5 miles)*	5.5 kgr./mm² *(3.49 Engl. t./sq. in.)*

Fig. 24.

10 080 000 pairs of wheels, having caused he same number of deflections on each iece of rail passed over.

Bringing this number into relationship vith the Wöhler extrapolated curves in igure 21, and bearing in mind what has een said above regarding the effects of mpact, it may be concluded that, in the resent state of the art of welding, the lectric resistance process, followed by suitable annealing, is the only one able to ensure a really satisfactory degree of safety throughout the life of a rail under heavy traffic, remembering that on the lines carrying the heaviest traffic on the Belgian railways renewal takes place after 8 years, whereas the fatigue testing machine, by repeated bending, produces the same total stress in a few weeks at most.

[656. 254]

Tickets,

Continued (*)

by LIONEL WIENER,
Professor at the University of Brussels.

PART C.

SYSTEMS OF TICKETTING.

Early railways continued the stage-oach practices : carriages, gauge, and ickets were all similar. Tickets with tubs and with very little printed upon hem were nominative. They were com-leted by hand; the destination, price, ame and address of the passenger, as ell as the date and number of the ticket, ere all written in. The tickets were onsecutively numbered so as to check hem, and to enable the seats in the train be allocated to passengers in the order n which the tickets had been sold. They ere collected when the passenger got nto the carriage, in which he was lock-d in. All the written information was uplicated, generally on the stub. As this ok some time, and the booking clerk ad to draw up a waybill as well, the oking offices were closed 15, later 5 inutes, before the trains started.

Examples of these early tickets are very arce. We are happy to have been able illustrate in *figures 47 and 5* the front nd back of a complete sheet of English per tickets of the year 1832, and in *fi-res 1, 2, 3 and 10,* early specimens used the Malines-Brussels railway, the oldest steam railway on the Continent (1835).

Edmondson changed the entire ticketting system when he introduced bearer, instead of nominative tickets, and when he invented cardboard tickets which, having become standardised, are still widely used to day.

As the accumulation of special tickets of each class and for all destinations caused too large a stock to be kept on hand, attempts were made to reduce it and to make a single ticket do instead of two or more of them; certain data were blank and the required ones written in as and when required. But the advantage accruing from the reduction of the number of tickets is offset, to some extent, by the amount of extra work thrust on the booking clerk, and by additional checking and accountancy.

A happy medium must therefore be struck, and no inflexible rule laid down. Preprinted tickets are to be used when there is a sufficient demand for them and, when there is not, tickets with one or several preprinted lists, supplied, and in exceptional cases, blank or « skeleton » tickets called to the rescue.

(*) See *Bulletin of the Railway Congress,* March 1938, p. 217.

We shall consider these different kinds of tickets in this order :

CHAPTER IV.

TICKETS FOR FIXED CATEGORIES AND PLACES.
Simple tickets, and tickets with detachable coupons.
Simultaneous issue of several tickets.
Interline tickets.

CHAPTER V.

LIMITED-PARAMETER TICKETS.

A. Parameters with preprinted lists.
Information completed in writing.
Information completed by perforation.
Information completed by severance.

CHAPTER VI.

LIMITED-PARAMETER TICKETS *(contd)*.

B. Parameters without printed lists (blank tickets).

CHAPTER VII.

COUNTERMARKS, AND EXCHANGE TICKETS.

* * *

CHAPTER IV.

TICKETS FOR FIXED CATEGORIES AND PLACES.

Edmondson tickets are generally used for internal or local, and even for through European services. In other cases, booklets of tickets or coupons are required.

But in America, Edmondson tickets are not favoured to the same extent. Apart from local or internal services, paper coupon-tickets are usually to be met with, one of the coupons being retained by the agent (or booking clerk) to be eventually transmitted to the auditor, and the other or others, in the case of return tickets, handed over to the passenger (figs. 148 to 150). For longer and particularly fo multi-line journeys, paper « band tickets are used *(fig. 15)*.

Definitions. — English road transpor Companies usually use the expressio « class of ticket » to designate a speci fied kind. As this may lead to confusio when dealing with railway tickets wher classes apply to accomodation provide by them at extra or lesser expense to th travelling public according to the clas travelled in, we shall use the word CATE GORY for distinguishing tickets issued t different kinds of passengers and retai the word CLASS for the accommodatio privided.

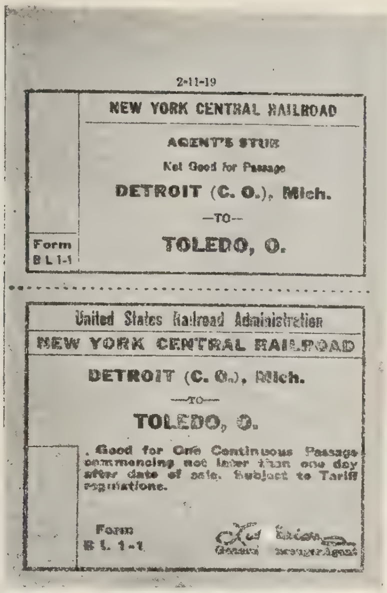
The arrangement of the text on a ticke constitutes the TYPE OF TICKET, frequentl called, for reference purposes, the FORM Tickets of the same category (such a military) may be printed in various ty pes. Those used between different place are simply different tickets. But, whe a ticket is made of cardboard instead o paper, or differs otherwise from anothe it is, or is not, a different KIND OF TICKE

As done previously, references to illus trations in other parts than Part C, ar shown *in italics*.

Railway tickets for given journeys. — Edmondson tickets are in general use i Europe, but the only thing they have i common is the cardboard on which the are printed. The text varies according t the method of ticketting, according to th category, and according to local practic

Curious to note, the earliest Edmond son tickets were undated. The name o the departure station, the destination sta tion, the class and the serial number o the ticket were given, and the number o the issuing station was occasionally in cluded (figs. 154-155).

The price, written in by hand or o



2-11-19

NEW YORK CENTRAL RAILROAD

AGENT'S STUB

Not Good for Passage

DETROIT (C. O.), Mich.

—TO—

TOLEDO, O.

Form B L 1-1

United States Railroad Administration

NEW YORK CENTRAL RAILROAD

DETROIT (C. O.), Mich.

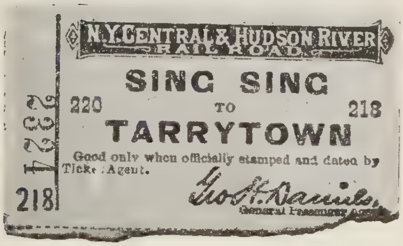
—TO—

TOLEDO, O.

Good for One Continuous Passage commencing not later than one day after date of sale. Subject to Tariff regulations.

Form B L 1-1

General Passenger Agent



N.Y. CENTRAL & HUDSON RIVER RAILROAD

SING SING

220 TO 218

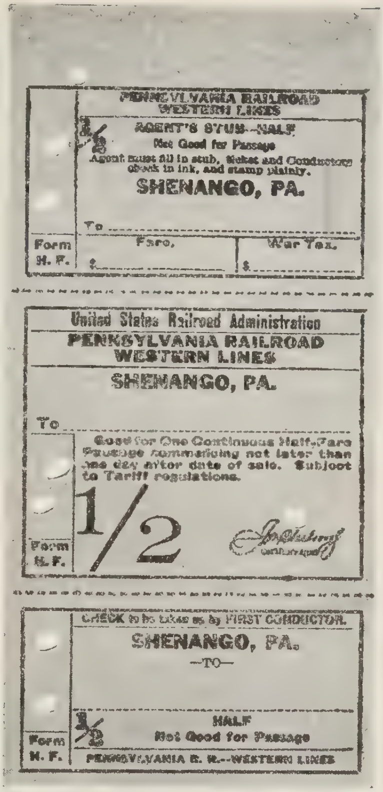
TARRYTOWN

Good only when officially stamped and dated by Ticket Agent.

Geo. H. Daniels

General Passenger Agent

218



PENNSYLVANIA RAILROAD WESTERN LINES

½ AGENT'S STUB—HALF

Not Good for Passage

Agent must fill in stub, ticket and Conductor's check in ink, and stamp plainly.

SHENANGO, PA.

To

Fare, $ | War Tax, $

Form H. F.

United States Railroad Administration

PENNSYLVANIA RAILROAD WESTERN LINES

SHENANGO, PA.

To

Good for One Continuous Half-Fare Passage commencing not later than one day after date of sale. Subject to Tariff regulations.

1/2

Form H. F.

CHECK to be taken up by FIRST CONDUCTOR.

SHENANGO, PA.

—TO—

½ HALF

Not Good for Passage

Form H. F.

PENNSYLVANIA R. R.—WESTERN LINES

American single paper tickets, with agent's stub. (Red. 3/4).

g. 148. — Fixed journey ticket — *New York Central R. R.* — Watermarked *Association Ticket Paper.*

g. 149. — Coupon of old single fixed journey ticket — *New York Central and Hudson River R. R.* — Name of the Company printed in negative type — From Sing Sing now Ossining) to Tarrytown.

Fig. 150. — Half price ticket to blank destination — With agent's control stub — Watermarked A. T. P. paper.

ionally machine printed, was seldom be found on old English tickets, and n was always omitted. It was once re included on certain tickets towards 1852 (1) and a decree issued in 1890 made it obligatory. On the Continent, such information has nearly always appeared (figs. 151 to 153).

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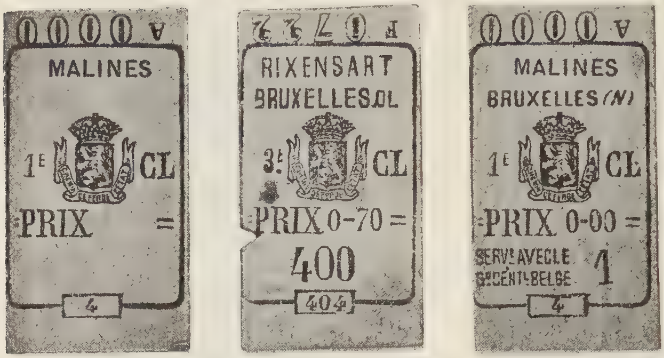
1) *North Eastern Ry.*, soon followed by the *London and South Western Ry.*



Belgian State Rys. old vertical Edmondson tickets, about 1855. (Red. 4/5) — With coat-of-arms, price, small number of issuing station in a rectangle, and large number of destination station at bottom — Skeleton figures.

Fig. 151. — Fixed issuing station to blank.

Fig. 152. — Fixed journey ticket.

Fig. 153. — Joint ticket.

(The *Grand Central Belge Co.* had no lines into or out of Malines or Brussels.)

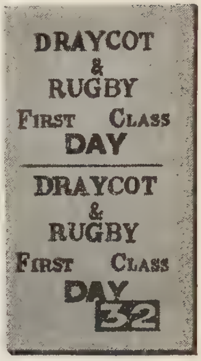
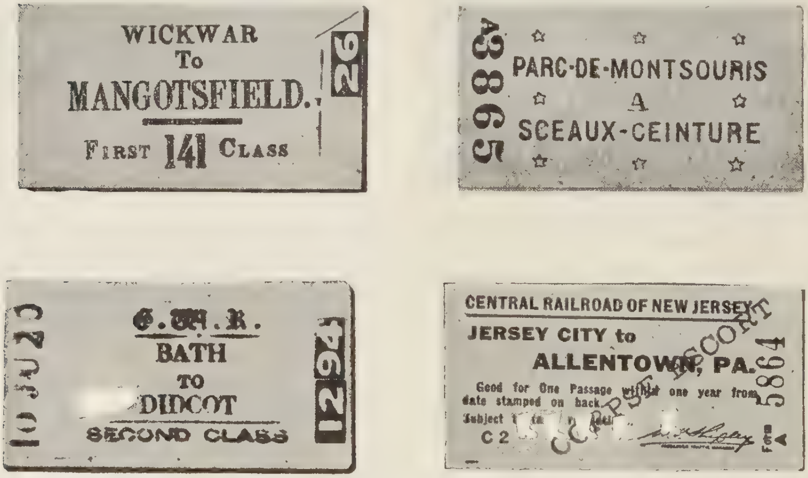


Fig. 154. — Old *Midland Ry.* return ticket (about 1845) — This ticket had to be torn in two — The journey was stated identically on both portions instead of down one way, and up the other. (Red. 4/5.)



Horizontal Edmondson tickets. (Red. 4/5).

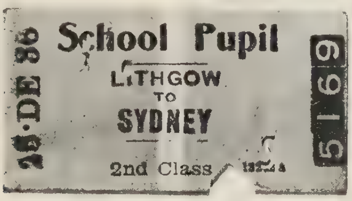
Fig. 155. — Old ticket with number of issuing station between « First » and « Class ».

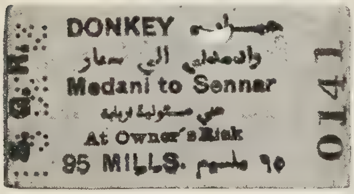
Fig. 156. — Old *Great Western Ry.* ticket (about 1850) — Company's initials in Gothic type.

Fig. 157. — Old *Ceinture Ry.* of Paris ticke

Fig. 158. — *Central R. R. of New Jerse* ticket — Category : « Corpse escort » Signature of general passenger agent Form number.

When required, other information was dded; in addition to the class, the name f the Company was given and also the ategory (figs. 158 to 160). Warnings vere included and when they became too engthy, were printed on the back of the ickets.





ig. 159. — Modern fixed journey ticket. (Red. 4/5) — *New South Wales Govt Rys.* — Category : school pupil — Date printed in ink — Number of ticket in negative type.

ig. 160. — Fixed journey ticket, *Sudan Government Rys.* — Dated by perforation — Printed in two languages (English and Arabic) — Category : Donkey ticket — At owner's risk.

Local paper tickets between fixed plas are not frequent (fig. 162). They are be found in two forms : the American band » tickets (fig. 149) and elsewhere, ocks of identical tickets (fig. 148).

RAILWAYS WITH FREQUENT SERVICES. — ckets for urban and suburban lines have to meet special requirements, in which speed and precision are of primary importance. In spite of simplified rates, artifices are resorted to to assist the passenger in finding where he must get out and to help the employee to check at a glance whether the ticket being handed to him should be collected at his station or elsewhere. Different devices have been tried in London and abroad, for meeting these requirements.

To distinguish between tickets of the « inner » and « outer » tracks of the Inner Circle line in London, all the *Metropolitan* and *District Rys.* local or through tickets bore in red, a capital « I », « O » or « E » (1) when the distance between the stations was the same either way (figs. 163-164).

On the *North London Ry.*, the tickets bore a large overprinted number (or numbers) indicating the destination (fig. 166) whilst on the *District Ry.*, their initial was overprinted in large skeleton letters (fig. 164). On other lines, tickets bore the initial letter both of departure and destination stations (figs. 167), and to make things clearer still, the *Charing Cross, Euston and Hampstead Ry.* added the number of the station. The *Central London Ry.* later overprinted the back of its tickets with a device which differed for each of its stations and which both passengers and the staff soon recognised and remembered (fig. 168). These devices were also repeated on the front of certain tickets *(fig. 88)*.

Some railways used tickets of different colours according to the arrival station (2), and the London tubes did alike

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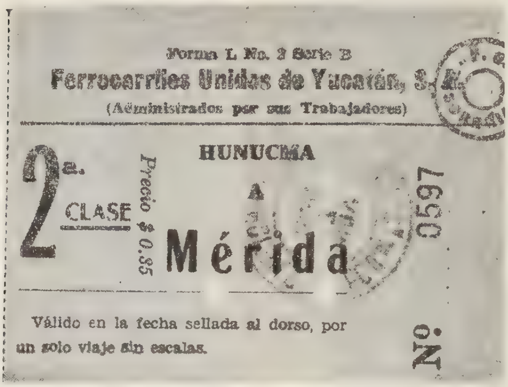
(1) « E » is the initial of the word « either ».

(2) This was the practice on the *Liskeard and Looe Ry.*, where all the tickets for Causeand were pink, and those for Coombe Jn. yellow; all 1st-class tickets were white. The *logher Valley Ry.* did the same. On the *City and South London Ry.*, from 1905, all tickets the Bank were beige, those to London Bridge, white; to Moorgate St., orange and to ld Street, violet.



Forma L No. 2 Serie B

Ferrocarriles Unidos de Yucatán, S. A.

(Administrados por sus Trabajadores)

2a. CLASE

Precio $ 0.35

HUNUCMA

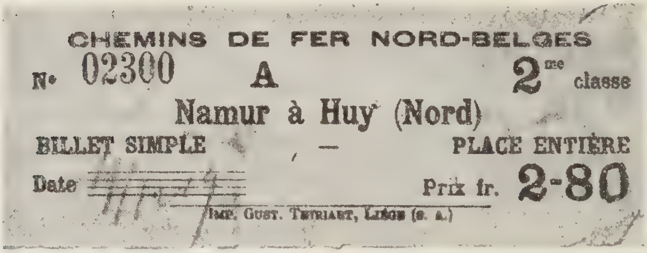
A

Mérida

0597

Válido en la fecha sellada al dorso, por un solo viaje sin escalas.

No.



CHEMINS DE FER NORD-BELGES

No 02300 A 2me classe

Namur à Huy (Nord)

BILLET SIMPLE — PLACE ENTIÈRE

Date Prix fr. 2-80

Imp. Gust. Thiriart, Liège (s. a.)

Fixed journey paper tickets. (Red. 3/4).

Fig. 161. — *Yucatan United Rys.*, administered by the Workmen (Mexico) — Overprinted with date and Company's guarantee stamps.

Fig. 162. — « *Nord-Belge* » *Lines* — Temporary single full-fare ticket issued immediately after the Armistice — Hand-dated.

when uniform rates were abolished (1). The former *Great Northern and City Ry.* (2) tickets were « underprinted » (if such a word may be coined), with differently coloured background, according to the station where the ticket was to be collected.

On the Berlin *Stadt- und Ringbahnen* the initials of both the departure and th arrival stations were clearly printed o either side of the upper part of the ticke (fig. 198).

THE CARADON RY.'S METHOD (3), was, w believe, quite unique. This mineral lin

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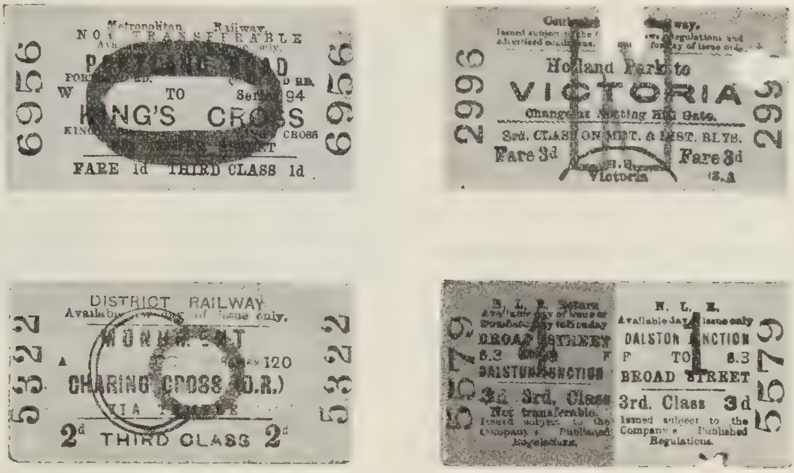
(1) Until the War, the *City and South London Ry.* had orange, the *London Electric* yellow, the *Piccadilly Tube* beige tickets, and the *District Ry.* green 3rd-class and white 1st-class tickets.

Towards 1930, the tickets of the *City and South London Ry.* were purple, those of the *London Electric*, pale blue, of the *Central London*, beige, and of the *District Ry*, pink.

(2) These tickets were made of stout paper rolls.

(3) Later the *Liskeard and Looe Ry.*



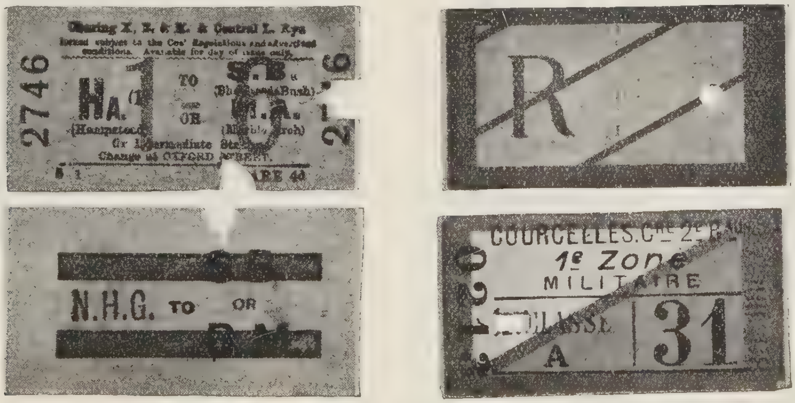
Edmondson urban railway tickets. (Red. 4/5).

g. 163. — Overprinted with route indication (O for « Outer line ») — London *Metropolitan Ry.* (1900 onwards).

g. 164. — Overprinted with route indication (red letter « O »), and black skeleton initial of the destination station — London *District Ry.*

Fig. 165. — Overprinted with green skeleton letter « N » showing the station where the passenger has to change trains — *Central London Ry.* — When the ticket is used for a child a semi-circular stub is cut out of the lower-portion.

Fig. 166. — Return ticket overprinted in black with the numbers of the destination stations — *North London Ry.*



Edmondson urban railway tickets. (Red. 4/5).

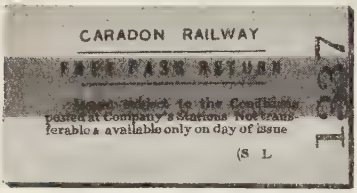
r. 167. — With distinctive initials of the stations names — Joint services of the *Charing Cross Euston and Hampstead line* and the *Central London Ry.* — Station numbers also overprinted.

. 168. — Back of a ticket bearing the distinctive mark of the destination station — *Central London Ry.* — Stations' initials.

Fig. 169. — Return ticket blank card of the Paris *Ceinture Ry.* — Reprinted with distinctive red frame, diagonals, and « R » for return.

Fig. 170. — *Ceinture Ry.* zone ticket — Category : Military — Bicolour ticket with number of the issuing station — Red frame and diagonal.

had no passenger coaches nor passenger tariffs of any kind and was unlicensed for the carriage of persons. And in spite of this, it managed to get around such minor difficulties and to convey passengers upon payment of appropriate fares. With this end in view, it gave away free tickets to whoever applied for them and did not object to travelling in goods wagons or vans and purchased cloakroom tickets which entitled the holder to convey his walking stick to such and such a destination or his overcoat to such other. This amusing practice remained in force until 1886 and recalls the way certain unlicensed London theatres got around their regulations which forbade their selling tickets for their performances (¹).



CARADON RAILWAY

FREE PASS RETURN

[illegible] to the Conditions posted at Company's Stations Not transferable & available only on day of issue

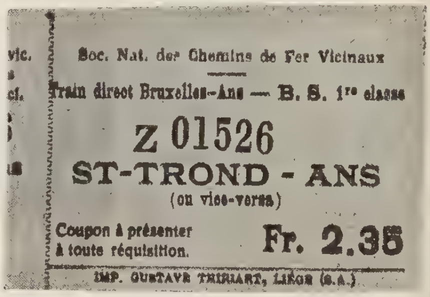
(S L

Fig. 171. — So called « Free pass » Edmondson ticket — *Caradon Ry.* (Red. 4/5).

EDMONDSON LIGHT RAILWAY AND TRAMWAY TICKETS FOR FIXED CATEGORIES AND DESTINATIONS (figs. 172 to 175). — Few such tickets are used. Some Companies issue them at booking offices, and paper tickets in the coaches. The *Brussels-Ixelles-Boendael Narrow-Gauge Ry. Co.* was an exception. It issued in all its carriages, diminutive thin cardboard tickets for each class and between any two places *(fig. 84)*. After a short time, a stu was added and these tickets bound i blocks.

On the other hand, most of the railwa belonging to the *Société Générale d Chemins de fer économiques* (²) had p per tickets from and to each place; owin to their number, they took up in spite o their small size, very much space.

Nevertheless, tickets of this syste have been reintroduced in Brussels, in modified form; each of them is only va lid to a fixed place on the outward jou ney and the same ticket is valid for a other trip on the return journey.



Soc. Nat. des Chemins de Fer Vicinaux

Train direct Bruxelles-Ans — B. S. 1re classe

Z 01526

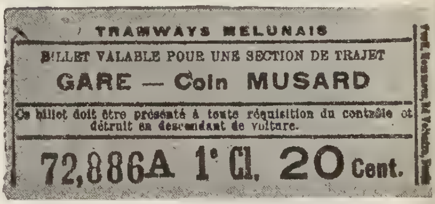
ST-TROND - ANS

(ou vice-versa)

Coupon à présenter à toute réquisition.

Fr. 2.35

IMP. GUSTAVE THIRIART, LIÉGE (S.A.)



TRAMWAYS MELUNAIS

BILLET VALABLE POUR UNE SECTION DE TRAJET

GARE — Coin MUSARD

Ce billet doit être présenté à toute réquisition du contrôle et détruit en descendant de voiture.

72,886A 1e Cl. 20 Cent.

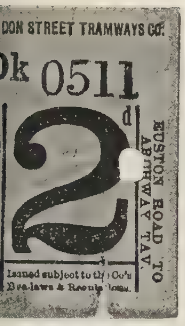
Paper tickets for fixed journeys. (Red. 3/4

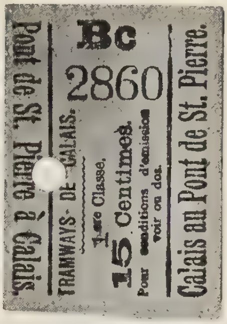
Fig. 172. — Through train run during th War, between Brussels and Ans — *Belgia National Light Rys. Co.* — (B. S. = Bill simple, or single ticket).

Fig. 173. — Ticket for one stage — *Melu Tramways*, France.

(¹) In order to attend gratis a performance at the Strand Theatre it was only necessary to buy a packet of chocolate at the shop opposite for a free seat in the stalls; other confectionery entitled the purchaser to a seat in the circle and so on.

(²) Such as in Brussels, on the Belgian coast, etc.


DON STREET TRAMWAYS CO.
k 0511
2d
EUSTON ROAD TO ARCHWAY TAV.
Issued subject to the Co's Bye-laws & Regulations.


Bc
2860
Pont de St. Pierre à Calais.
TRAMWAYS - DE - CALAIS.
1ère Classe.
15 Centimes.
Pour conditions d'émission voir au dos.
Calais au Pont de St. Pierre.

ld road transport soft cardboard tickets.
(Red. 4/5).
g. 174. — *London Street Tramways Co.*, 1886 — Available either way.
g 175. — *Calais Tramways* — Similar to previous ticket, same date.

SIMULTANEOUS ISSUE OF SEVERAL TICKETS
R THE SAME JOURNEY. — When the relat-
e values of the unit rates for the diffe-
nt classes allow it, two tickets of a low-
class may be issued instead of a single
e of a little used higher class. The
ck of tickets in the stations may thus
reduced.

This method was in force in Austria
ere certain stations issued a single Ed-
ndson ticket for a 3rd, two tickets for
2nd, and three for a 1st-class journey.
is still applied in Belgium where the
fference between 2nd and 1st-class tra-
is exactly the amount of a 3rd-class
ket.

In England the 3rd-class paper tickets
ued by the *Sheppey Light Ry.* bore the
scription :

> irst class passengers to hold two third
> s tickets.

Elsewhere, it is the practice to issue
single tickets instead of a return
et, one being valid for the outward,
the other for the return journey
g. 176).

On certain suburban tramways, the difference in price between 1st and 2nd-class tickets is constant. To halve the number of tickets required, 2nd-class tickets are always issued and, when necessary a supplementary ticket for the higher class is sold at the same time (1).

Tickets with detachable coupons. — Although the tickets always cover a complete journey, they can be constituted in different ways. A single ticket between the departure and destination places may be supplied, even if the journey takes place over sections belonging to several Companies (fig. 177), or including different means of transport. It is also possible, in order to facilitate inspection as well as the formalities for stopping en route, to provide paper tickets with detachable coupons, each of which corresponds to a given section of the journey.

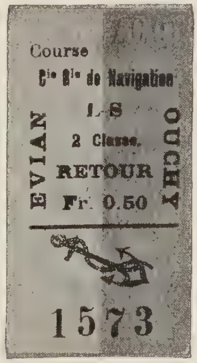


Fig. 176. — One of the two tickets simultaneously issued for a return journey. (Red. 4/5) — *Compagnie Générale de Navigation*, Geneva — With symbolic navigation vignette (anchor).

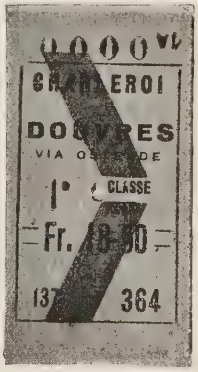
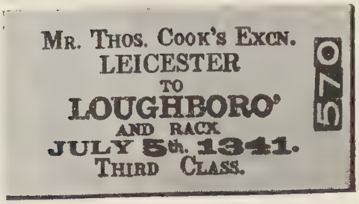


Fig. 177. — Through ticket for combined rail and sea journey — *Belgian State Rys.* (1850) — With station numbers — Overprint in distinctive colour.

) Brussels-Tervueren line.



MR. THOS. COOK'S EXCN.
LEICESTER
TO
LOUGHBORO'
AND BACK
JULY 5th. 1841.
THIRD CLASS.
570

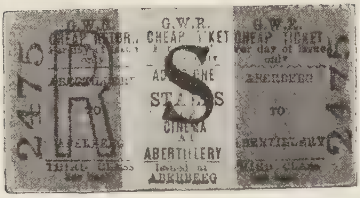


Fig. 178. — One of *Cook*'s earliest excursion tickets, issued in 1841. (Red. 4/5).

Fig. 179. — Three-coupon cheap return ticket, one coupon of which admits to a cinema — *Great Western Ry.*

Further coupons may apply to expenses other than transport, such as meals, hotel charges, etc. One of the earliest journeys of the kind, arranged by *Thomas Cook*, cost £ 527-15-0 (1).

Edmondson tickets cannot, owing to their limited size, include more than three coupons. These may consist of two coupons for the outward and return journey and a stub coupon as a check, or else two coupons for given sections with a central coupon for a journey to be made by some other means of transport or for an auxiliary service (fig. 179) (2).

The route covered by the booklets or « bands » of coupons is fixed, or drawn up to meet the requirements of the holder. We only deal here with the former.

Such booklets comprise a number of coupons of the same class or, occasionally contain, over different stretches, coupons of different classes. Special booklets are issued for certain special classes of passengers, such as tourists or members of a party travelling together. Some of these are issued at reduced rates, as week-end booklets, excursions for ramblers, etc.

The coupon for a sea passage usuall bears some distinctive mark and vignett *(fig. 90)*, and is frequently exchanged for a landing card or countermark.

The same booklets are used both fo adults and children. The first page ha a detachable coupon; when it is unsevered, the booklet is valid for an adult an sold at full price; if detached, the booklet is sold, at half price, for a child.

Similar arrangements have been extended to other categories of tickets suc as those allowing a given journey to b made several times at reduced rates.

Unlike booklets of coupons for a singl or return journey to and from a state destination and along a fixed route, booklets of « combined coupons » are mad up for practically any itinerary chose by the passenger, each of the coupon corresponding to a specified section Tickets of this kind were formerly onl issued by the German *Verein* and its associates. In 1921, however, an *International Union for the Issue of Combine Coupons* was created and drew up a se

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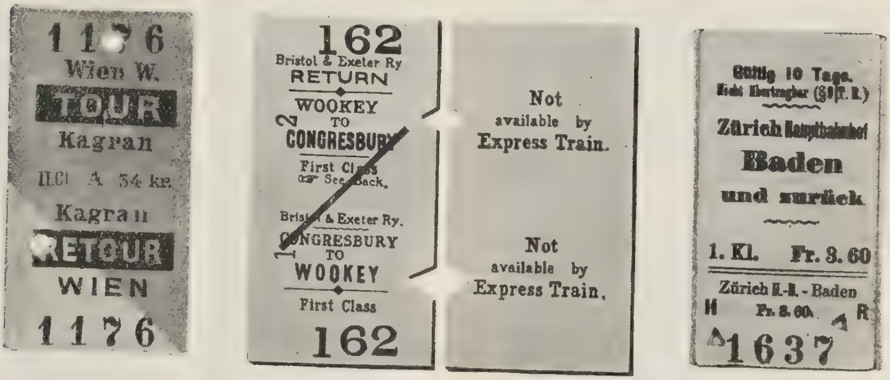
(1) This was one of the first tours arranged by *Cook's*. Books of 300 coupons (owing to the great number of small railway companies concerned) each costing £ 250, were used for another of this Agency's European tours, in which 100 persons took part.

(2) The *Belgian State Rys.* formerly issued through tickets from Dover to various Belgian towns, although part of the journey was made on the State-owned steam packets, and the rest over the State railways (fig. 177).



Edmondson vertical return tickets. (Red. 4/5).
Fig. 180. — Austrian « tour » and « return » ticket — With special bicolour schemes.
Figs. 181-182. — *Bristol and Exeter Ry.* (about 1871) — The two parts of the ticket are numbered « 1 » and « 2 » — Not available by express train.
Fig. 183. — Swiss unseparable return ticket (1905) — Validity, 10 days.

f regulations concerning them. It issues ckets for :

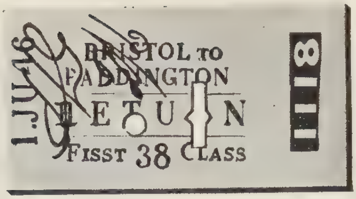
- single journeys;
- return journeys;
- circular journeys;
- journeys consisting in part of circular tours d in part of return trips;
- journeys which are not continuous.

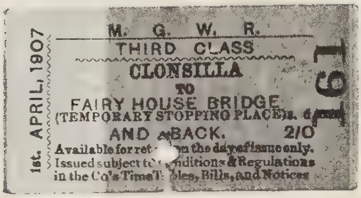
Their coupons frequently bear special dications. Many of them have a num- r of spaces which are to be perforated stamped at certain possible stopping aces; others include control coupon-sec- ns for alternative routes. Most of the lian coupons are numbered with hund- ls of kilometres, which have to be pped at the stopping places; Hungarian upons are printed with lists of the days the months, and hours, both on the upon itself and on its vertical child ntrol section.

In America, the coupons forming a gle ticket are placed beneath each er so as to form a long band; they are severed along the previously prepared perforations that separate them from each other. The first coupon (at the bottom) is the auditor's check, and the last of them (at the top) gives full information concerning the journey and furthermore is valid for the last section. The intermediate coupons correspond to the other sections of the journey.

Tickets for two journeys. — The most usual are the return tickets (Swiss « double trip » tickets, American « round trip tickets ») which were introduced so as to induce passengers to return by rail.

Edmondson return tickets generally have separate portions for the outward and return journeys (figs. 180 to 182). In Switzerland, Central Europe, and some other countries, no portion of ticket is detached at the end of the outward journey, and the passenger keeps it intact untill the return journey is completed (fig. 183). In America, apart from local tickets, paper tickets or « bands » comprising





Edmondson horizontal return tickets. (Red. 4/5).

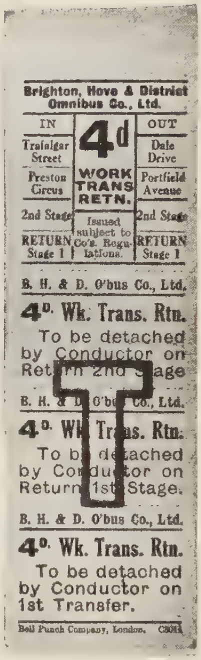
Fig. 184. — Old *Great Western Ry.* type (1846) — Merely printed : « Return » — Number of issuing station (38) — Special clipping — Fare written in, if need be, by hand.

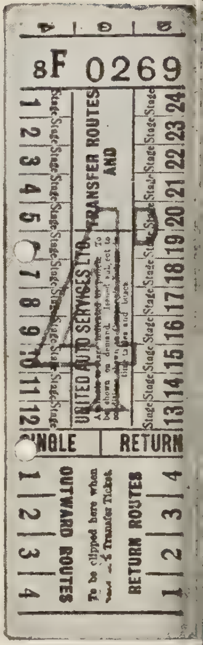
Fig. 185. — Ticket to a « temporary stopping place » — *Midland Great Western Ry.* (Ireland) — Date printed on ticket — Category : special excursion.

the customary successive coupons are used.

Paper tickets, or in Great Britain, soft cardboard ones, are often used for road transport (figs. 186 and 187). So as to prevent the return portion being used over again, it is frequently exchanged for a countermark.

Railway scheme return tickets are valid outwardly to and back from any of a number of listed stations. In some cases, the return trip may be made from a different station to the arrival one, the passenger travelling between the two as he likes and at this own expense, as the journey between them is not taken care of by the ticket.


Brighton, Hove & District Omnibus Co., Ltd.
IN
OUT
4d
Trafalgar Street
Dale Drive
WORK TRANS RETN.
Preston Circus
Portfield Avenue
2nd Stage
2nd Stage
RETURN Stage 1
RETURN Stage 1
B. H. & D. O'bus Co., Ltd.
4D. Wk. Trans. Rtn.
To be detached by Conductor on Return 2nd Stage
4D. Wk. Trans. Rtn.
To be detached by Conductor on Return 1st Stage.
4D. Wk. Trans. Rtn.
To be detached by Conductor on 1st Transfer.
Bell Punch Company, London.



Soft cardboard tickets for British road transport. (Red. 4/5.)

Fig. 186. — Through return ticket availab each way on two lines in succession — *Brighton Hove and District Omnibus C Ltd.* — With 3 detachable coupons — Cat gory : Workman — Overprinted T (tran fer), in skeleton letter.

Fig. 187. — Single or return ticket of fixe value, valid over one of the routes name on the stage shown by perforation — *Uni ed Automobile Services Ltd.* — Fare ove printed, in skeleton figure.

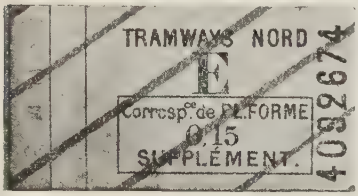
TICKETS FOR REPEATED JOURNEYS. — Blocks or packets of Edmondson (1 *(figs. 87, 88, 373 and 374)* (2) or of p per tickets *(fig. 103b)* are issued for a complishing a number of times the sam trip, each of the tickets being valid, a occasion may arise, over one, two, thr or more successive lines.

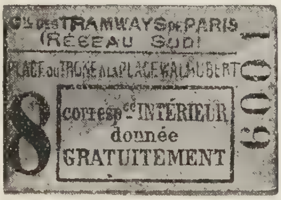
---

(1) London underground railways and English tramways.

(2) Continental companies.

Elsewhere, such packets of Edmondson ickets are issued for accomplishing a ingle or return trip every day of the veek *(fig. 318)*, one of the tickets being reprinted for each day, or all of them aving to be used before a given date. Ve shall return to these questions in the ourse of the chapter dealing with season ickets and passes.





Old cardboard transfers issued in Paris about 1884. (Red. 4/5.)

g. 188. — *Nord Tramways Co.* — Platform transfer — Letter showing issuing line — These tickets were printed with seven-igure numbers — Overprinted diagonals lesignating second class.

r. 189. — *Paris Tramways Company* (South-rn system) — Free 1st-class transfer — Vith the number of the line — Dated stub as been collected in second car.

Road transport. — Through tickets are issued over two urban lines of the same kind, or between urban and suburban lines and metropolitan railways.

In Paris, a 1st-class trip used to entitle the passenger to a free transfer ticket (in cardboard) (1); on the upper deck a supplement had to be paid to obtain it (figs. 188 and 189). Elsewhere a single ticket is issued for the two journeys (figs. 190 and 191). In certain cases, the ticket is mutilated in the second car, either by detaching a coupon or by tearing off a corner, or else by perforating it to prevent its being used again; in others, it is collected and an exchange ticket given in its stead

Many Companies delivered two tickets, one of which was valid in the first car, and the other, together with the first, in the second, where both tickets were rendered valueless for future use (2).

Similar methods have been applied to road-rail services. English through tickets are valid for 2 or even 3 successive journeys. They are made either of soft card or, in the case of duplex tickets, of strong paper (fig. 224).

In America and sometimes in Europe (3), where this system is widely used, the long paper transfers have sometimes one or two stubs which the conductors of the different cars detach in succession (figs. 190-191).

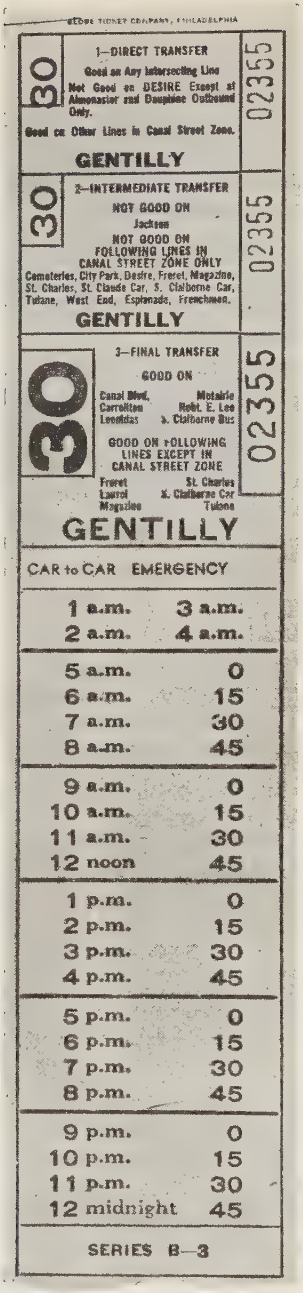
It is indispensable that these tickets should show the time and date of use. We will return to this point hereafter.

---

(1) *Compagnie Générale des Omnibus de Paris*, and *Tramways du Département de la ine.*

(2) In Brussels, where the supplementary ticket cost 5 centimes.

(3) As in Stettin.



GLOBE TICKET COMPANY, PHILADELPHIA

30
1—DIRECT TRANSFER
Good on Any Intersecting Line
Not Good on DESIRE Except at Almonaster and Dauphine Outbound Only.
Good on Other Lines in Canal Street Zone.
GENTILLY
02355

30
2—INTERMEDIATE TRANSFER
NOT GOOD ON
Jackson
NOT GOOD ON
FOLLOWING LINES IN
CANAL STREET ZONE ONLY
Cemeteries, City Park, Desire, Freret, Magazine, St. Charles, St. Claude Car, S. Claiborne Car, Tulane, West End, Esplanade, Frenchmen.
GENTILLY
02355

30
3—FINAL TRANSFER
GOOD ON
Canal Blvd. Metairie
Carrollton Robt. E. Lee
Leonidas S. Claiborne Bus
GOOD ON FOLLOWING
LINES EXCEPT IN
CANAL STREET ZONE
Freret St. Charles
Laurel S. Claiborne Car
Magazine Tulane
GENTILLY
02355

CAR to CAR EMERGENCY

1 a.m. 3 a.m.
2 a.m. 4 a.m.

5 a.m. 0
6 a.m. 15
7 a.m. 30
8 a.m. 45

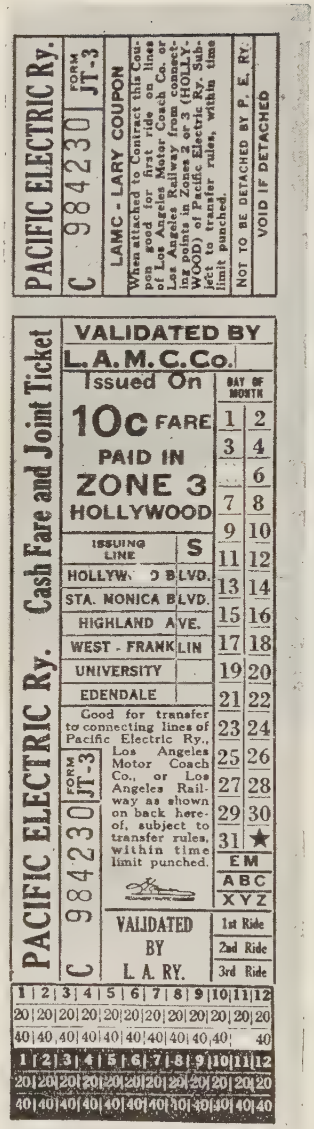
9 a.m. 0
10 a.m. 15
11 a.m. 30
12 noon 45

1 p.m. 0
2 p.m. 15
3 p.m. 30
4 p.m. 45

5 p.m. 0
6 p.m. 15
7 p.m. 30
8 p.m. 45

9 p.m. 0
10 p.m. 15
11 p.m. 30
12 midnight 45

SERIES B—3



PACIFIC ELECTRIC Ry.
C 984230
FORM JT-3
LAMC - LARY COUPON
When attached to Contract this Coupon good for first ride on lines of Los Angeles Motor Coach Co. or Los Angeles Railway from connecting points in Zones 2 or 3 (HOLLYWOOD) of Pacific Electric Ry. Subject to transfer rules, within time limit punched.
NOT TO BE DETACHED BY P. E. RY.
VOID IF DETACHED

PACIFIC ELECTRIC Ry. Cash Fare and Joint Ticket
VALIDATED BY
L.A.M.C.Co.
Issued On
10c FARE
PAID IN
ZONE 3
HOLLYWOOD
ISSUING LINE S
HOLLYW D BLVD.
STA. MONICA BLVD.
HIGHLAND AVE.
WEST - FRANKLIN
UNIVERSITY
EDENDALE
Good for transfer to connecting lines of Pacific Electric Ry., Los Angeles Motor Coach Co., or Los Angeles Railway as shown on back hereof, subject to transfer rules, within time limit punched.
FORM JT-3
C 984230
VALIDATED BY L. A. RY.

DAY OF MONTH
1 2
3 4
6
7 8
9 10
11 12
13 14
15 16
17 18
19 20
21 22
23 24
25 26
27 28
29 30
31 ★
EM
ABC
XYZ
1st Ride
2nd Ride
3rd Ride

1|2|3|4|5|6|7|8|9|10|11|12
20|20|20|20|20|20|20|20|20|20|20|20
40|40|40|40|40|40|40|40|40|40| |40
1|2|3|4|5|6|7|8|9|10|11|12
20|20|20|20|20|20|20|20|20|20|20|20
40|40|40|40|40|40|40|40|40|40|40|40

American transfers. (Red. 3/4).

Fig. 190. — Available at *New Orleans* over three successive lines — Ticket with two control stubs — Body for use with Globe Ticket Co.'s cutter, showing hours and fractions in groups.

Fig. 191. — Cash fare and joint ticket transfer with control stub — *Pacific Electric Ry.* — Available over the lines of three different companies — Limited line parameter — Day of the month — Hours and fractions of hours (20 minutes) — Six figures to ticket number — Midday to midnight shown in negative type (white on black).

CHAPTER V.

LIMITED PARAMETER TICKETS.

A. — Parameter tickets with preprinted lists.

Using distinct tickets for each category nd between any two places is expensive : heir intrinsic value is notable and their nominal value, considerable. Much room s required to store them and a continuous check has to be kept on them. Any vay of reducing their number is there-ore worth considering, bearing in mind hat the following information has to be hown on every ticket : origin, destina-ion and (if need be) route, category and lass, as well as the fare, besides data for hecking purposes which included the umber (and possibly series) of the cket, the date of use and period of va-dity. All these are, in fact, parameters.

We have examined tickets for speci-ed journeys. The present chapter deals ith those one or several factors of hich vary, whilst the others remain xed. The former are really interdepen-ent, as the price, for instance, depends n the other factors.

The parameters may either be quite ndefined or consist of limited preprint-d lists, from which the elements apply-g to any given journey are selected. We ll examine these different cases, be-nning with tickets having fewest para-eters and most fixed factors, and end-g with blank tickets where all the fac-rs vary, and some are fixed.

The principle of the system is to list e (or several) series of indications cor-sponding to one (or several) parame-s in a given order, and to select in each t (or lists) the factor (or factors) ich apply to a given journey. When price of a ticket is fixed, the other factors only serve control or statistical ends. But when the price depends on the passenger's requirements, a factor of each list has to be selected. It then becomes necessary to show these factors on the ticket without possibility of fraud or error and, at the same time, to provide facilities for checking purposes. This is done according to one of the four following methods :

(*a*) By pencil indication on the ticket and stub or counterfoil;
(*b*) By perforation or clipping;
(*c*) By severing a portion of the ticket;
(*d*) By means of a duplicate copy.

In this way it is no longer necessary to stock tickets for each factor of a list; a single set of tickets is sufficient for use with any element of the entire list.

Definitions. — A CHECK-TICKET is a ticket of no value in itself, having all the indications which appear on the ticket issued to the passenger.

DUPLEX, TRIPLEX, ETC. TICKETS are those folded on themselves along one (or several) perforated lines, with the printing so arranged (generally symmetrically) that when the ticket is clipped the perforations occur on the same place on each part.

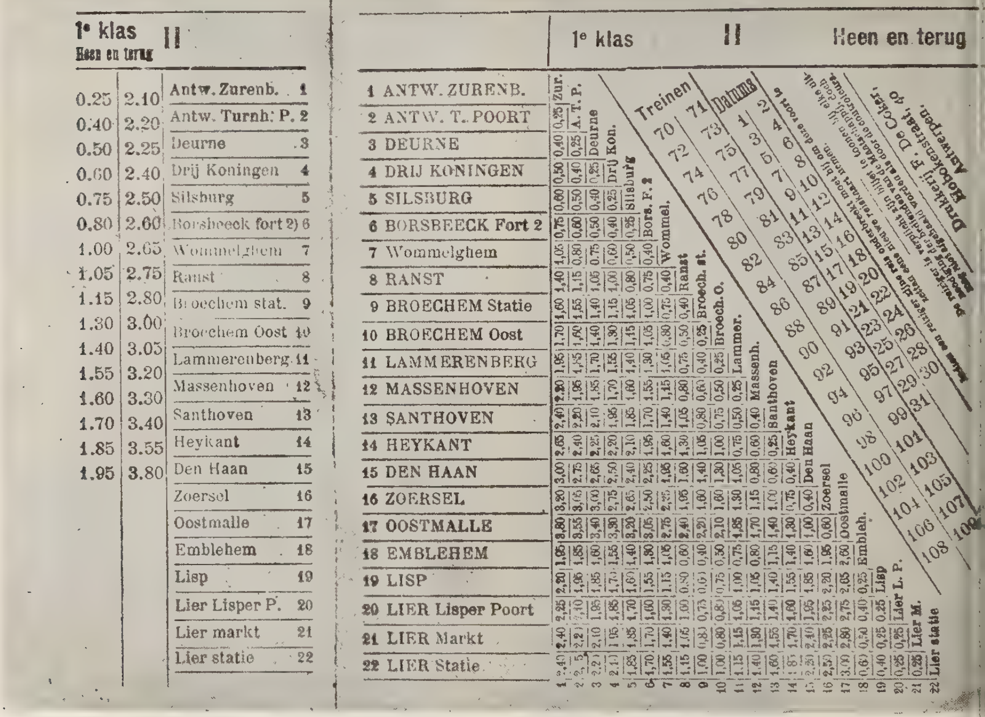
SIMPLEX TICKETS also show the necessary indications on both parts. This system requires special instruments, known in America, as cash fare cutters, to show which factors of the lists refer to a given journey. This is generally done by leaving a projection on the ticket and stub after it has been removed from the cutter.

A DUPLICATE is a check-slip which receives, usually by means of carbon paper, such additional indications as are filled in by hand when the ticket is issued.

(A) PENCIL INDICATIONS.

Formerly widely used on light railways. A list of all the stations was shown in a column duplicated on the attached control stub (fig. 192). An extra stub with the same list was inserted between the ticket and the control stub of return tickets.

Different single and return, besides half-fare tickets, were used for each class The ticket itself bore a table, usually triangular in form, which showed in double entry the fares between the differen places. Owing to an ingenious arrangement, by which the stations were stepped the names appeared once only. Thi table was generally printed on the o verse, but sometimes on the back of th ticket (1).



1e klas II
Heen en terug

0.25	2.10	Antw. Zurenb. 1
0.40	2.20	Antw. Turnh. P. 2
0.50	2.25	Deurne 3
0.60	2.40	Drij Koningen 4
0.75	2.50	Silsburg 5
0.80	2.60	Borsbeeck fort 2) 6
1.00	2.65	Wommelghem 7
1.05	2.75	Ranst 8
1.15	2.80	Broechem stat. 9
1.30	3.00	Broechem Oost 10
1.40	3.05	Lammerenberg 11
1.55	3.20	Massenhoven 12
1.60	3.30	Santhoven 13
1.70	3.40	Heykant 14
1.85	3.55	Den Haan 15
1.95	3.80	Zoersel 16
		Oostmalle 17
		Emblehem 18
		Lisp 19
		Lier Lisper P. 20
		Lier markt 21
		Lier statie 22

1e klas II Heen en terug

1 ANTW. ZURENB.
2 ANTW. T. POORT
3 DEURNE
4 DRIJ KONINGEN
5 SILSBURG
6 BORSBEECK Fort 2
7 Wommelghem
8 RANST
9 BROECHEM Statie
10 BROECHEM Oost
11 LAMMERENBERG
12 MASSENHOVEN
13 SANTHOVEN
14 HEYKANT
15 DEN HAAN
16 ZOERSEL
17 OOSTMALLE
18 EMBLEHEM
19 LISP
20 LIER Lisper Poort
21 LIER Markt
22 LIER Statie

Fig. 192. — Preprinted lists, « passe partout » ticket. (Red. 3/4) — *Belgian National Light Rys. Co.* — Lists of train numbers — Days of the month — Table of fares — Stub with list of possible fares for which the ticket can be issued. (Date, 1905.)

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(1) Tickets of the *Imprimerie Mommens* (Brussels) type used by the *National Light Railways Company.*

On the Antwerp—Bergen-op-Zoom—Tholen line, the lines and columns of the table, rectangular in shape and on the back of the ticket, were only headed with numbers; these were repeated on the front in the list of places.

For a given journey, all the conductor ad to do was to draw two horizontal ines through the column of places, one n a level with the departure, and the ther with the destination station. The able quoted the fare.

A list of the numbers of the trains vas sometimes added, and on return ickets, lists of dates and hours. The inermediate stub was collected on the eturn journey. It served for auditing, nd its removal prevented the ticket being sed a second time. In Italy (1) the fare rom the departure station was shown eside the lists of places, and occasionaly, in a second column, the fares from ther places.

Not being sufficiently safe, this system as been abandoned everywhere.

(B) INDICATIONS BY PERFORATION.

This method, which offers the greatest afeguards, together with great facilities, the most extensively used. The checkng or auditing departments retain a ragment of the ticket itself or a duplice which it is next to impossible to ounterfeit.

The most widely used control fragment the Bell Punch System's which detaches om each ticket, the colour of which ries according to the category and lue, by means of special clippers, called e Bell Punch, a small clipping which rves for auditing and statistical purses.

In a second method, double or triple kets, whose counterfoil shows in the oper order, indications identical with ose of the ticket itself, are used. It is ded back against the ticket so that th (or all three) parts can be snipped at once, the same data being clipped into each. A portion of the ticket is handed to the passenger who is enabled to check if for himself; another is kept by the booking clerk or the conductor and, if need be, a third part is sent directly to the accountancy department.

The use of duplex emergency soft cardboard tickets with or without preprinted lists is fairly general in Great Britain.

On the Continent, this method is only used in the case of paper tickets which are folded symmetrically along a perforation parallel to the vertical side. Formerly, some of these tickets were folded diagonally, so that each portion was triangular in shape *(fig. 117)*.

In America, these paper tickets are folded lengthways, no matter how printed. The *Manila Ry.* (Philippine Islands) is one of the few railways whose duplex tickets are folded parallel to the smaller side.

The long American « band » tickets rank in a class by themselves; the main indications are repeated on the auditor's stub by the duplex method.

We shall group the applications of the system as follows :

A single limited parameter — value-parameter;

A single limited parameter — place-parameter; sections or stages of journey;

A single parameter — categories and classes-parameter;

Two limited parameters — sections or stages and categories;

Two limited parameters — sections or stages and fares;

Two limited parameters — places and categories;

More than two parameters.

---

(1) Guidova-Brescia-Mantova-Costiglie light railway *(Interprovincial Railways)*.

It will be noticed that this examination is much more thorough than in the case of tickets without parameters, but the subect is a more complex one and needs careful consideration.

GROUP OR PARTY TICKETS. — The use of collective tickets, which originally were only used for troops, is gradually being extended to others, such as members of recognised clubs, of scientific excursions, congress delegates, sports associations, etc. This causes, as a corollary, the issue of countermarks or tokens. Formerly, the number of persons covered by a single ticket was limited in Germany, to 4 first-class passengers, 6 second-class and 8 third and fourth-class; in the States, to 8; in France, to 15 and so on. Though such limitations have been removed, they are still in force in some other countries.

The number of passengers is, therefore, also a parameter.

A single limited parameter. — *(a)* VALUE PARAMETER. — The simplest examples of such tickets, in addition to the name of the Company, only bear a list or table of fares in which the one applying to the journey has to be selected and marked (fig. 219).

(b) PLACE PARAMETER. — Tickets should supply data concerning three geographical factors : place of departure, destination, and itinerary. We have previously dealt with tickets between fixed places, which only show a single element fo each of these factors. In the prese case, we have to consider tickets wit preprinted parameter lists, among which one such factor is to be selecte and perforated. We shall consider her after blank tickets whereon each of the factors is filled in by hand, so that the can be selected instead of only from tho printed in a limited list, from among any of the existing ones.

A SINGLE PARAMETER — DIFFERENT DEST NATIONS. — For each category of passe gers, the fare is the same to all plac situated at the same distance from th departure station. Their names are list on multiple-destination tickets, where the other data are fixed.

This system was first introduced Belgium (¹) in the nineties (fig. 194 All the data were originally printed the face of the ticket, but when biling alism was introduced (French a Flemish), shortage of space forced t destinations to be printed at the bac The same thing occurred in Hungary.

In England, this system was introduc on the *Baker Street and Waterloo R* under the name of « scheme tickets », the 1st January 1911. It was gradua extended to the other underground ra ways (²) and made it possible, in 19 to withdraw from circulation, thou there is but the single class in the Lo don Tubes, 7 000 kinds of tickets. T

(¹) *National Light Rys. Co.*

(²) The *City and South London Ry.* introduced it on the 1st September, 1914, but i was not extended to the local and common fund bookings of the *Piccadilly*, the *Hampstea* and the *Central London Rys.* until 1922.

On the 1st November, 1926, it was extended to the through tickets issued between th *Central London*, the *Piccadilly* and the *Hampstead Rys.* on the one hand, and th *Metropolitan Ry.* on the other.

The *District Ry.* adopted this system on the 1st January, 1927, and the following mont it was extended to the *East London Ry.*'s through tickets.

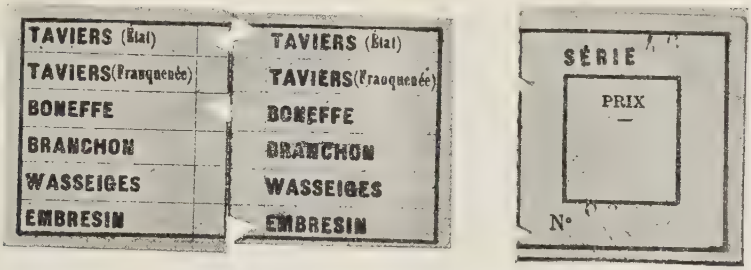
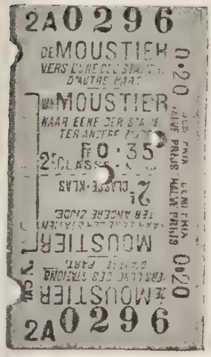
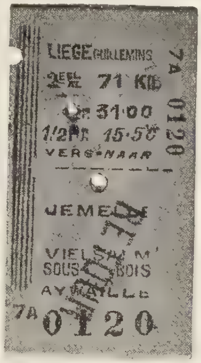
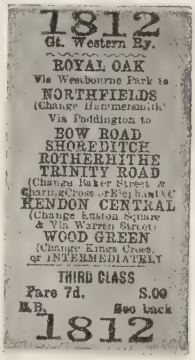
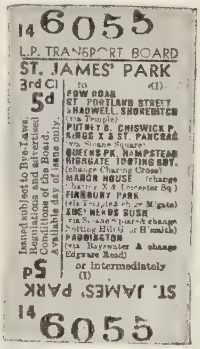


Fig. 193. — Obsolete 1.10-m. (3' 7 5/16") gauge *Noville-Taviers-Embresin Ry.* (Belgium) — Front and back of a thin card ticket — On the obverse : printed list of stations — On the reverse : the fare charged was filled in by hand. (Red. 3/4.)









Edmondson scheme tickets. (Red. 4/5).

ig. 194. — Destination stations on the back — *Belgian State Rys.* — Ticket printed in two languages, French and Flemish — Stamped with date vertically — Could be severed into two half-price tickets with fare repeated on each half.

ig. 195. — Ticket with space left for name of extra unforeseen station — *Belgian National Rys. Co.* — Printed in two languages with destination stations on back — Could be used for half price or return ticket — Number of ticket repeated laterally on upper half.

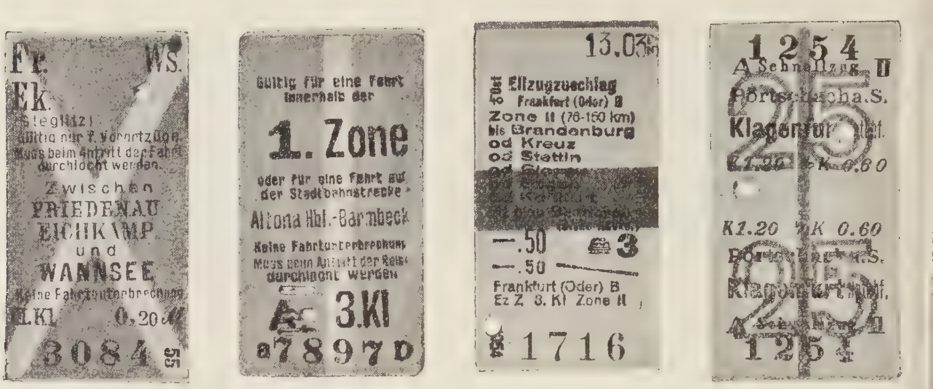
ig. 196. — Scheme ticket for urban lines — Certain journeys involve one or two changes of train, exchange stations being stated in each instance — *Great Western Ry.*

ig. 197. — *London Passenger Transport Board* scheme ticket.

petus having been given, the other kets were carefully studied in order suppress those rarely used. The num- of different kinds was thus further duced from 50 000 to 20 000.

The tickets of the *London Passenger nsport Board* have up to 15 different tinations printed on them (fig. 197), d there are nearly as many on the main-line Companies' suburban railways. They also show, besides the destinations, the name of the stations where the passenger changes trains (fig. 196).

There are fewer equidistant stations on the main lines, but in spite of this, as soon as there are more than four, they take up too much room on the ticket. This led to a happy innovation being in-



Zonal tickets. (Red. 4/5).

Fig. 198. — Berlin suburban lines — With initial letters of station names at uppe corners — Distinguishing uncoloured white cross.

Fig. 199. — Hamburg suburban lines single-zone ticket — Also good for journey ove urban section of line.

Fig. 200. — Express supplement for IInd zone (76 to 150 km.) — *Deutsche Reichsbahn* — Different destination stations given.

Fig. 201. — Zonal express ticket *(Austrian Südbahn)* — Zone number overprinted in skeleton figures.

troduced in Belgium (fig. 195). As some of the equidistant stations are hardly patronised, only the three most frequently used are preprinted and a « grid » is provided for writing the names of any others, whether existing or new ones.

The same idea led to the introduction of RATING ZONES, with the same fares to all stations of each zone, though they are not exactly equidistant from the departure station. This further reduces the number of different tickets and speeds up their issue. These zones must be small, otherwise there is a risk of losing the passengers for the nearer places or too large a portion of extra receipts f the greater distances. Over long runs, t difference between the zonal and the a ual rates is small compared with the to fare.

Besides reducing the number of diff rent kinds, it was hoped this would d velop travel. The promoter, Minister B ross, introduced the zone system, in Hu gary, on the 1st August 1889. He bas the cost of long journeys on the reduc spending capacity of the population, a arranged the other rates accordingly (

This system was soon extended to oth countries. The *Austrian State Railwa*

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(1) Apart from the 1st zone [1 to 25 km. (15.5 miles)] and the XIVth [226 kn (140 miles) and over] the 10 intermediate zones (II to XI) were all 15 km. (9.3 miles long, and zones XII and XIII were 25 km. long.

The 3rd-class fare was 0.125 florin for the 1st zone of 25 km. and increased by 0.25 flo rin per zone of 15 km. as well as for the XIIth; this made it 3 florins for 200 km. (12 miles). 0.15 florin was added for the XIIth 25 km. long zone, and the same amou (making 4 florins) for the XIVth zone, above 225 km.

50 % was added to these amounts for the second-class fares, and 100 % for first-clas fares.

ntroduced it as from the 16th June, 1890, nd the *Emperor Ferdinand's North ailway*, as well as the *North-West* and *ustrian State Railways Company*, soon fterwards (1). The unit zonal rate in ustria differed from the others in that varied from one group of zones to nother.

The *Südbahn* (fig. 201) used zonal ates based on a sliding scale, but as reırn tickets were still issued for distances nder 133 km. (82.6 miles), the whole cheme was invalidated (2).

The Dutch rates included groups of zoes with sliding scales; beyond a certain istance, ordinary kilometric rates aplied (3).

Finally, so as to simplify tariffs, a comined rate system has recently been inroduced in Belgium : it is a kilometric ne up to 30 km. (18.6 miles) and zonal, eyond (4). Owing to the smallness of e zones, the difference between these res and the real rates is negligible.

URBAN AND SUBURBAN LINES. — By the t October 1891, Prussia had already followed Austria and Hungary's lead and introduced zonal rates on certain of the Berlin suburban lines. But they were based on principles the exact opposite of the Belgian. Short distances up to 20 km. (12.4 miles) have zonal rates, kilometric rates being used beyond (5). As the double object, when introducing these rates, was to simplify and accelerate the distribution and handling of tickets, special tickets were printed which differed in many ways from the others, and used in Berlin and on other large towns' suburban lines (figs. 198 and 199). As a matter of fact, new tickets have been devised wherever zonal rates have been introduced.

These rates were also adopted by the *Chemin de fer de Petite Ceinture* (Paris) which introduced two separate zones (6) (fig. 170). The *Italian State Rys.* use at Naples a modified form of the system, the tickets being valid to any place between two given stations on the line, which actually limit a zone.

Certain urban lines went further still and adopted uniform rating, whatever the distance. The *Central London Ry.*'s fare was 2 d., whence its name of « Tuppenny Tube », and on the Paris *Metropolitain*, 25 centimes for 1st, 15 centimes for 2nd singles, and 20 for 2nd return tickets, used to be charged (fig. 268). Uniform fares have been given up in London, but are still in force in Paris, though they have been increased. When the fare is always the same, it need no longer be quoted on each ticket.

---

(1) The basic rates increased up to 200 km. (124 miles), after which they remained onstant. The others were rated as follows :
from 0 to 50 km. (0 to 31 miles) — 10-km. (6.2 miles) zones.
from 50 to 80 km. (31 to 50 miles) — 15-km. (9.3 miles) zones.
from 80 to 100 km. (50 to 62 miles) — 20-km. (12.4 miles) zones.
from 100 to 200 km. (62 to 124 miles) — 25-km. (15.5 miles) zones.
above 200 km. (124 miles) — 50-km. (31 miles) zones.

(2) Unit rates according to the class : 1, 2 or 3 kr. per km. with 50 % supplement or the express trains, in spite of the law of 1877 only authorising an increase of 20 % or the latter.

At small stations, one, two or three tickets used to be issued to the passenger according o whether he was travelling third, second or first-class.

(3) From 1 to 150 km. (93 miles), there were three 50-km. (31 miles) zones;
rom 150 to 240 km. (93 to 150 miles), there were also three zones, of 30 km. (18.6 miles) depth each only;
bove 240 km. ordinary kilometric rates applied.

(4) Kilometric rates up to 30 km. (18.6 miles);
rom 31 to 60 km. (18.2 to 37.3 miles), 3 km. (1.86 miles) deep zones;
nd above this, 5-km. (3.1 miles) zones.

(5) The third-class fares were 10, 20 or 30 pf., and the second 15, 30 and 45. Beyond his, kilometric rates of 3 pf. for third class and 4.5 pf. for second class were in force.

(6) There were thus for each of the two classes single and return full, half and quarter, are tickets.

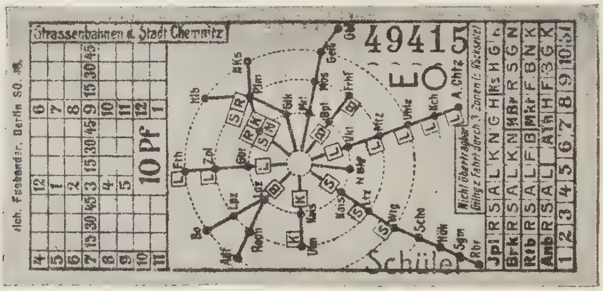

Strassenbahnen d. Stadt Chemnitz
49415
E
10 Pf
Schüler

Fig. 202. — Zonal tramway ticket *(Chemnitz)*. (Red. 3/4).
With map of lines, zone circles, and reference table.
At the top of the ticket : hours and quarters of an hour.

Many urban American railways have retained the single 5-cent fare, regardless of the distance. Mention must be made of a curious special device to be found in New York, where the use of exit coupons makes it possible to pay a higher fare for certain journeys and still retain uniform fares. We shall return to them further on (fig. 298).

OTHER ZONAL RATES are frequently used in countries such as Germany, Holland, Czechoslovakia, Poland and Austria, where speed supplements are still charged. A a rule, only the depth of the zone i stated, but occasionally, as on the back o some old German card supplements fo *E* trains (1), and certain *Netherlands Rys* paper tickets and *Swiss Federal Rys* Edmondson tickets, a list of all the stations in the zone is printed upon them.

Zone fare tickets are very generall used for bicycles and other objects accompanying passengers (2).

TRAMWAYS AND OMNIBUS SERVICES. — Owing to their lines being so interwove tramways seldom use zonal rates, whic suit only radiating systems. Paper ticke with graphical representation of the system, and numbered concentric circles corresponding to the rating stages, are the used (3), the proper number being perforated in overprinted lists. Elsewher (fig. 202), a letter is printed at each stag point and a reference table relates thes to the important places (Chemnitz).

---

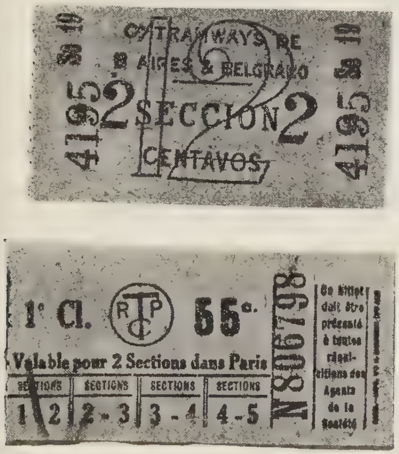
(1) In Germany the zones are of 75 km. (43.5 miles) for both D and E trains. A supplement of 1 Rm. is charged on the former.

(2) In Great Britain especially.

(3) In Düsseldorf.

It is obviously impossible to use this ystem when the lines cross each other nstead of radiating from the centre (1).

A single parameter — different start- ng places. — These comprise the return ıalves of scheme tickets; the *London Pas- enger Transport Board's*, for instance, ıre valid for as many as 15 different pla- es (fig. 197).


Cía TRAMWAYS DE
B. AIRES & BELGRANO
2 SECCION 2
CENTAVOS
4195
1e Cl.
RTP
55c.
Valable pour 2 Sections dans Paris
SECTIONS
1-2
2-3
3-4
4-5
N 806798
Ce billet doit être présenté à toutes réquisitions des Agents de la Société

ckets for un-named line sections. (Red. 3/4).

g. 203. — For 2 sections — *Buenos Ayres and Belgrano Tramways* (1880) — Amount of fare overprinted.

g. 204. — For « two sections in Paris » — *Transports en commun de la Région pa- risienne* — List of pairs of sections — 6-figure number.

In North America, as in the Philippi- s and Central America, where the rail- ays are run on the same lines, apart om a limited number of preprinted kets, the others comprise limited or un- nited destination-parameters. They are valid from the station whose name is stamped on the back to the station stated on the face, where it is selected from among a list of names (limited parameter) or else, more generally still, to a destination written in by hand (unlimited parameter). A couple of examples will show how this is worked :

(a) SIMPLE « BAND » MULTI-ROUTE TICKET of the *Denver and Rio Grande Ry.*, from the station stamped on the face to the destination as written in, via one of a series of alternative routes over lines owned by 15 different Companies.

Beginning at the lower end, this « band » paper ticket includes : the auditor's control-coupon duplex of the last journey-coupon of the band on which is written « via Ogden or Salt Lake City » one of which must be clipped), and the names of the 15 Companies concerned.

The first journey-coupon is valid over the Company's own line *(Denver and Rio Grande)* from the issuing station to the other Company's junction station (Ogden or Salt Lake City);

The second coupon is valid from the junction, over the lines of one of 4 different Companies, to one or other of 18 different places listed;

The third coupon, which is also the body or stub, is valid from this latter place over the lines of one or other of fifteen Companies (2 of them navigation Companies) to the destination as written in.

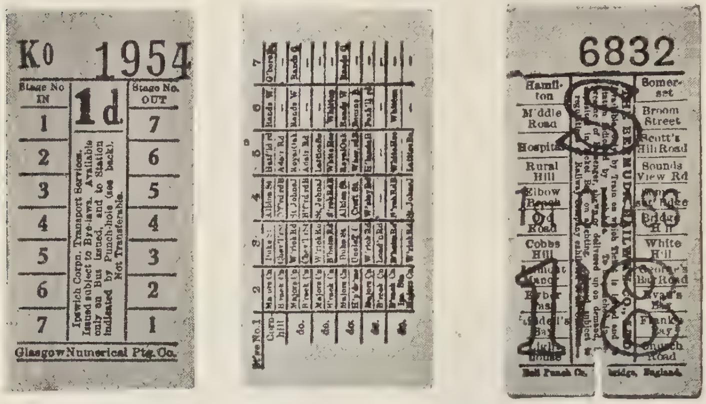
For possible transfers at Butte (by one or other of three different routes) and at Salt Lake City, there are additional coupons above the stub (2).

(b) RETURN « BAND » (ROUND TRIP) TICKETS from a station on the *Denver and Rio Grande Ry.* to any place on the *Colorado Southern*. This paper ticket includes

---

(1) Several Companies issue special « centre » tickets on which are listed all the jour- ıeys for which they are valid (London, Brussels, Ghent).

(2) Each of the journey-coupons repeats the indications of the 3 alternative series for ach of which there is a coupon, but only the series corresponding to the coupon is printed n heavy type.



Stage-parameter tickets. (Red. 4/5).

Fig. 205. — Ticket with lists of stages either way — *Ipswich Corporation Transport* — Reference table on back of ticket.

Fig. 206. — Ticket with list of stages — The *Bermuda Rys. Co. Ltd.* — Class and fare overprinted.

separate coupons for the outward journey over each of the railways, and return coupons over each of them, besides an auditor's coupon at the bottom, and a large journey-coupon forming the body of the ticket at the top.

A single parameter — journey stages. — Tramways and omnibus services with progressive tariffs often have separate tickets for each fare; railway Companies also, on certain trains *(fig. 306)*. Stages are numbered or quoted either according to their point of origin, or as constituting sections of line. The tickets either list all the sections of one line (figs. 203 to 208) (1), or parts of the line or all the lines of the system (fig. 209) (2), or again, when the system is a very intricat one, the « centre » stages only (3).

Unfortunately, useful as this inform ation is to the passenger, it takes up t much space and this becomes worse whe the number of the stage point is adde For this reason, the names of the place are often left out and only their numbe printed (figs. 203-204). Sometimes a com promise is achieved and the initial lette of the stage points given (4), or else th names of the more usual routes are quo ed and the others merely numbered (5

The *Bell Punch Co.* has for a long tim manufactured soft cardboard tickets c which the list of starting points is printe in a first column and the termini of th

---

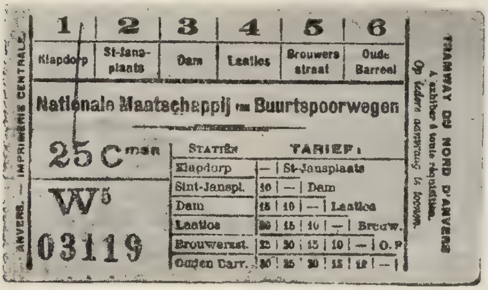
(1) *Liége-Maestricht Ry.;* little used local lines of the *Belgian Rys.*, etc.

(2) *Nord Ry.*, *Lausanne Tramways;* Bordeaux return tickets.

(3) Paper tickets (Brussels, and Ghent), London tickets.

(4) *New Caledonian Ry.*, *Lille Tramways*, *Paris and Seine Dept. Tramways.*

(5) Bournemouth.



1	2	3	4	5	6
Klapdorp	St-Jans-plaats	Dam	Leatles	Brouwers straat	Oude Barreel

Nationale Maatschappij van Buurtspoorwegen

25 Cmen

W5

03119

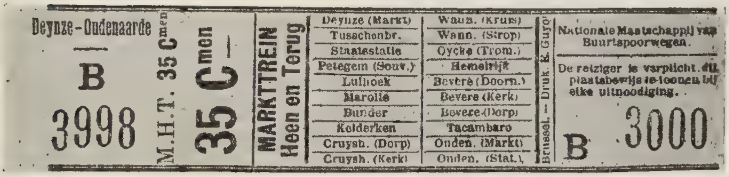
Statiën	Tarief:					
Klapdorp	—	St-Jansplaats				
Sint-Janspl.	10	—	Dam			
Dam	15	10	—	Laatlos		
Laatlos	20	15	10	—	Brouw.	
Brouwerst.	25	20	15	10	—	O. P.
Ouden Barr.	30	25	20	15	12	—

ANVERS. — IMPRIMERIE CENTRALE.

Op ieder aanvraag te toonen.

A exhiber à toute réquisition.

TRAMWAY DU NORD D'ANVERS



Deynze-Oudenaarde

B

3998

M.H.T. 35 Cmen

35 Cmen

MARKTTREIN
Heen en Terug

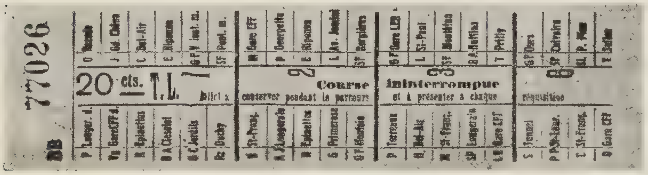
Deynze (Markt)	Waus. (Kruis)
Tusschenbr.	Wann. (Strop)
Staatsstatie	Oycke (Trom.)
Petegem (Souv.)	Hemelrijk
Lulhoek	Bevere (Doorn.)
Marolle	Bevere (Kerk)
Bunder	Bevere (Dorp)
Kelderken	Tacambaro
Cruysh. (Dorp)	Ouden. (Markt)
Cruysh. (Kerk)	Ouden. (Stat.)

Brussel. — Druk. E. Guyot

Nationale Maatschappij van Buurtspoorwegen.

De reiziger is verplicht dit plaatsbewijs te toonen bij elke uitnoodiging.

B 3000



77026

20 cts. T.L.

Billet à course ininterrompue

conserver pendant le parcours et à présenter à chaque réquisition

Fixed-price paper tickets for sections of one or several lines. (Red. 3/4).

Fig. 207. — Single ticket for journey on one line only — *Belgian National Light Rys'. subsidiary Co. : North Antwerp Tramway Co.* (1895) — With reference table of fares.

Fig. 208. — Return ticket for journey on one line only with list of stops — *Belgian National Light Rys. Co.* — Category : Market train.

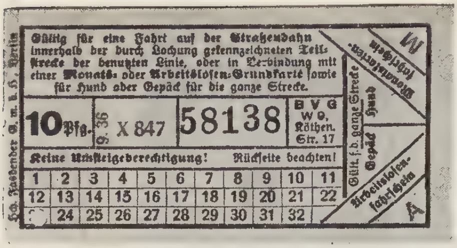
Fig. 209. — Single ticket available over several lines — *Lausanne Tramways* — The lines are numbered.

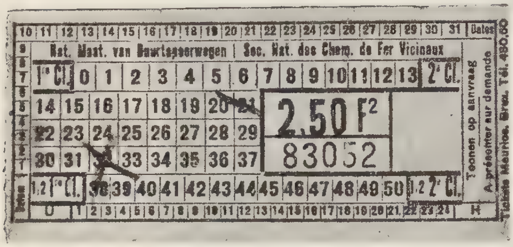
ifferent stages in a second (fig. 206). n this way, a single perforation shows oth the beginning and end of the jour-ey.

When there is insufficient place on the ce of the ticket, longer tickets are used 5 mm. (3 3/4") or even 115 to 130 mm. 1/2" to 5 1/8") instead of 65 mm. 9/16")] and, if necessary, the list is continued on the back. Printing devices make the lists as clear as possible.

Some Companies list the stages instead of the starting places. In Paris, tickets mention « 2 stages intra muros » and list them : 1-2, 2-3, 3-4, and so on. In England, tickets bear the words « 1st, 2nd, 3rd stage », and so forth.

REFERENCE TABLES are printed on one


Gültig für eine Fahrt auf der Straßenbahn innerhalb der durch Lochung gekennzeichneten Teilſtrecke der benutzten Linie, oder in Verbindung mit einer Monats- oder Arbeitsloſen-Grundkarte ſowie für Hund oder Gepäck für die ganze Strecke.
10 Pfg.
9. 36
X 847
58138
B V G
W 9,
Köthen.
Str. 17
Keine Umſteigeberechtigung!
Rückſeite beachten!
1 2 3 4 5 6 7 8 9 10 11
12 13 14 15 16 17 18 19 20 21 22
24 25 26 27 28 29 30 31 32
Gült. f. d. ganze Strecke
Hund
Gepäck
Monatskarten-fahrſchein
M
Arbeitsloſen-fahrſchein
A
Fa. Fasbender G. m. b. H., Berlin



Fixed-price paper tickets available on any section of the system — With a list of the stage point numbers. (Red. 3/4).

Fig. 210. — *Berlin Transport* — With control stubs for workmen or monthly season - Optional categories : dog or luggage.

Fig. 211. — *Belgian National Light Rys. Co* - Class : First or second — With day of the month and hour.

side of the ticket (1) or even at the back (2). The tickets are simpler and perforation holes no longer occur at inconvenient places, rendering the text illegible.

It is only one step from the reference tables to graphical representation. The first map of a system appears to hav been used on tickets issued in Antwer during the 1885 Exhibition; this was fol owed, in 1894, by the *Averly Electr Tramways* inside the Lyons Exhibitio (figs. 212 and 213). Since then, ma have been frequently used instead of lon lists of places, particularly in German in Austria, Belgium, Holland, the Unite States, Japan and elsewhere. There is a in so arranging the map that the whole c it remains clear in spite of the sma space available for it. The stage point c the stage (according to which of them listed) is perforated at the place show on the map or in the reference tab (figs. 215-216).

The *Fasbender Printing Works*, Berli have specialised in this type of wor which it carries out admirably, even i the case of such complex systems as t Krefeld ones (fig. 214). Their maps a frequently printed in two colours and t routes shown in different kinds of line

A SINGLE PARAMETER — CATEGOR (TICKETS OF FIXED VALUE). — It is now po sible to avoid stocking tickets of the v rious categories by printing a list of cat gories, among which one is selected a perforated. As each category correspon to a given rate, category- and class-par meters are often combined.

British road transport having but single class, use them on a large scale (

---

(1) At Mors the obverse of the paper ticket only bears the line numbers, whereas the table is at the back. Ipswich is one of the few towns where soft cardboard tickets hav a double-entry table, which is also at the back.

Similar lists occur on the Düsseldorf *(Rheinische Bahngesellschaft)* and Hamburg *(Hoch- und Unterbahn)* paper tickets. The corresponding numbers are overprinted in triangular spaces.

(2) At Hanover, the stage points are numbered, as also at Solingen, where a referenc table is added.

(3) In Birmingham, the same ticket covers the following categories : « Ordinary return », « Excursion », « Workman return », « Shopping return ». Elsewhere « Child » « Ordinary » and « Workman » are frequently to be met with on the same ticket.

Two parameters with pre-printed lists : LACES AND CATEGORIES (with fixed value or each ticket). — The length of the ourney that can be made for the same are differs according to the category.

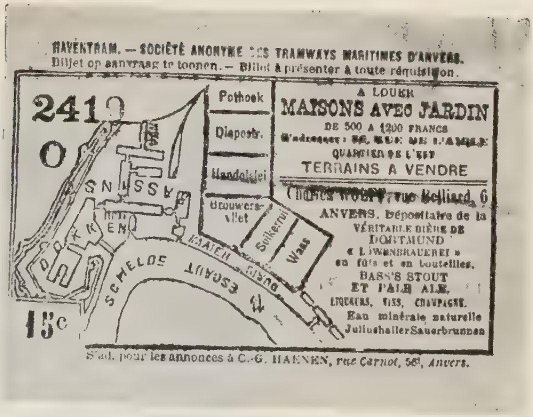
On British road transport tickets, loner journeys at reduced rates are freuently added to the list of usual joureys (1). In some cases, these reduced ares only apply at certain hours of the ay (2).

Amongst Railway Companies, the rench *Est* issues to passengers travelling rom level crossings, single paper tickets hich come under this heading (fig. 217). hey are printed with a double entry tae of fares; the names of places served ead the columns, and the categories, the orizontal lines (3). A single clipping of e amount to be paid shows both the urney and category of traveller.

TWO PARAMETERS WITH PRE-PRINTED SEES : ROUTES AND FARE. — The French t Railway also issues return tickets with double list of places and fares, one for outward, the other for the return urney. Obviously, a ticket for each ss is needed.

The *Bell Punch Co.* has printed similar kets for light railways (4) who use difent ones in either direction (fig. 220).

SEVERAL PARAMETERS WITH PRE-PRINTED rs (fixed value for each ticket). — The ps, designated by a list of numbers, the egories and control lists (dates and urs), constitute as many parameters,



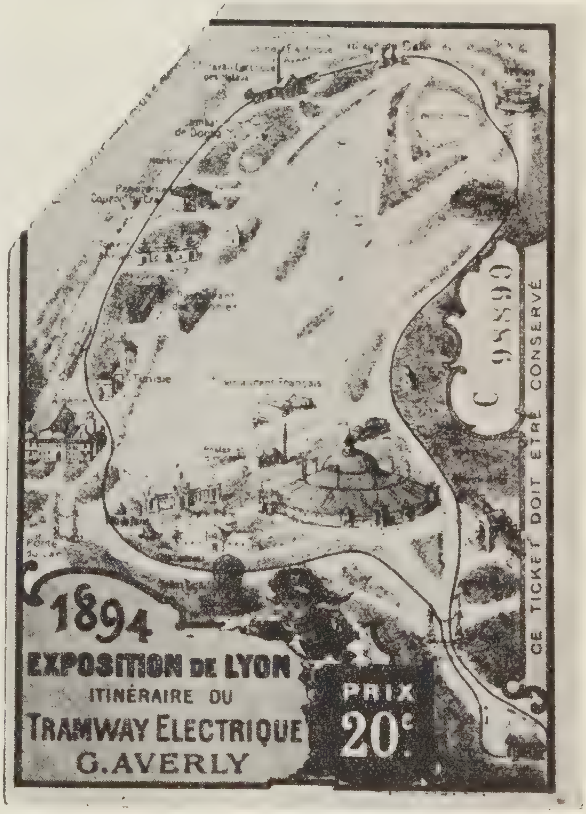
HAVENTRAM. — SOCIÉTÉ ANONYME DES TRAMWAYS MARITIMES D'ANVERS.
Biljet op aanvraag te toonen. — Billet à présenter à toute réquisition.

2419
O
15c

A LOUER
MAISONS AVEC JARDIN
DE 500 A 1200 FRANCS
S'adresser : 56, RUE DE L'AMBLE
QUARTIER DE L'EST
TERRAINS A VENDRE

Charles Woutt, rue Kelliard, 6
ANVERS. Dépositaire de la
VÉRITABLE BIÈRE DE
DORTMUND
« LÖWENBRAUEREI »
en fûts et en bouteilles.
BASS'S STOUT
ET PALE ALE.
LIQUEURS, VINS, CHAMPAGNE.
Eau minérale naturelle
JulitshallerSauerbrunnen

S'ad. pour les annonces à C.-G. HAENEN, *rue Carnot, 56*, *Anvers*.



1894
EXPOSITION DE LYON
ITINÉRAIRE DU
TRAMWAY ELECTRIQUE
G.AVERLY

PRIX
20c

C 98890

CE TICKET DOIT ÊTRE CONSERVÉ

First tickets bearing map of line. (Red. 3/4).

Fig. 212. — *Antwerp Maritime Tramways* (1885) — With advertisements on the face.

Fig. 213. — *Averly Electric Tramway* at the Lyons Exhibition, in 1894 — Chromolithograph — Triangular stub.

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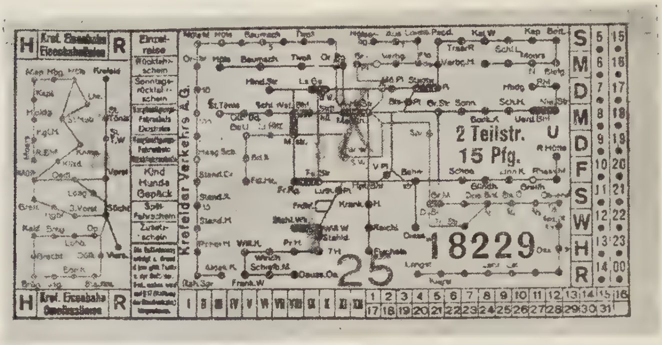
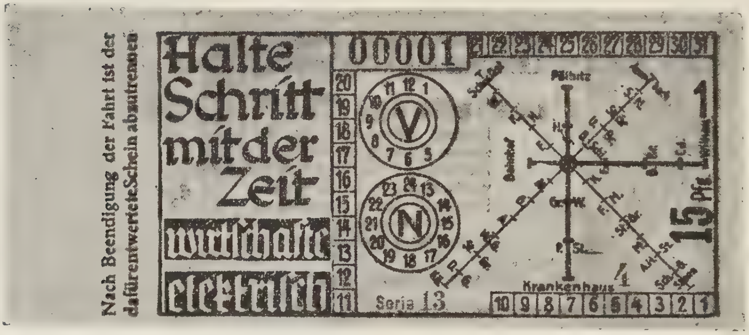
1) In London the cheap or workmen's fares listed after the ordinary ones.

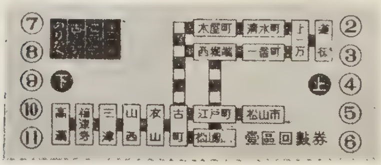
2) At Hastings, after the list of usual s, comes that of half price fares for jours before 9 o'clock in the morning.

3) These categories are military half and fares, 2nd or 1st class.

) Groningen-Paterswolde-Eelde line (fig.




Nach Beendigung der Fahrt ist der dafürentwertete Schein abzutrennen
Halte Schritt mit der Zeit
wirtschafte elektrisch
00001
V
N
Bahnhof
Krankenhaus
15 Pfg.
1
Seria 13



Tickets with map of line. (Red. 3/4).

Fig. 214. — Map in two colours — *Krefeld* — Category parameter — Month, date, day hour and half hour — Numbers of the lines — Direction of journey.

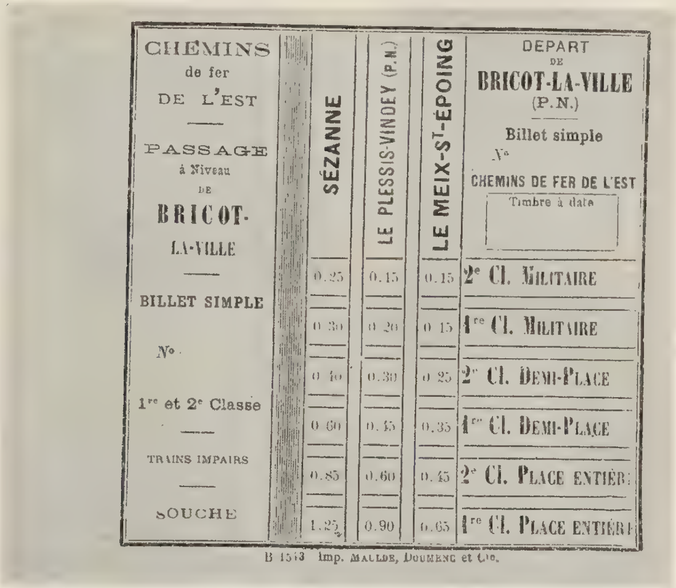
Fig. 215. — Diagrammatic map — Day of the month; two dials for the morning and evening hours — The ticket has been extended on one side to provide advertising space on the face.

Fig. 216. — *Tokyo Metropolitan Ry.* coupon.

one factor of each of these lists having to be perforated.

This method is used on nearly all the lines of the *Belgian National Light Rys. Co.* (fig. 211).

Duplex and triplex tickets. — Britis American and Continental paper ticke of the kind differ considerably from ea other. British duplex tickets are alwa joined along the long side and the prin



CHEMINS
de fer
DE L'EST

PASSAGE
à Niveau
DE
BRICOT-
LA-VILLE

BILLET SIMPLE

N°

1^{re} et 2^e Classe

TRAINS IMPAIRS

SOUCHE

SÉZANNE	LE PLESSIS-VINDEY (P.N.)	LE MEIX-S^T-ÉPOING	DEPART DE BRICOT-LA-VILLE (P.N.) Billet simple N° CHEMINS DE FER DE L'EST Timbre à date
0.25	0.15	0.15	2^e Cl. Militaire
0.30	0.20	0.15	1^{re} Cl. Militaire
0.40	0.30	0.25	2^e Cl. Demi-Place
0.60	0.45	0.35	1^{re} Cl. Demi-Place
0.85	0.60	0.45	2^e Cl. Place entière
1.25	0.90	0.65	1^{re} Cl. Place entière

B 1513 Imp. Maulde, Doumenc et Cie.

Fig. 217. — Single parameter ticket with double-entry table of fares — Red. 3/4 — French *Est Ry.* — Various categories.

ng appears symmetrically on the same ace of the opened ticket. When the rinting is identical on each part instead f being symmetrical, the corresponding ndications coincide when the ticket is olded. Duplex tickets are mostly used or road transportation.

The simplest of them only have a list f fares. They may differ for each cateory (1) or have a list of categories, so s to use the same tickets for all of hem (2).

Elsewhere, tickets are valid for so many ips. Besides the lists of fares and trips, they bear control indications : the numbers of the trips, date of expiration (one month), and date of each journey (month and day of the month) (3).

They are frequently used as emergency, single and return tickets. They then show a list of places among which the desired departure and destination points are perforated, and a list of fares (fig. 225). Control indications are added : day and month, direction of journey (4).

The *London Passenger Transport Board*, which took over the various local Companies, still issues through road-and-rail

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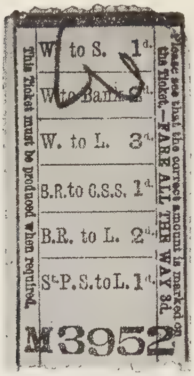
(1) *Hants and Dorset Motor Services Ltd.*, dog tickets.

(2) At Hastings.

(3) *Northern and Associated Companies.* The fare in shillings and pence was perforated once for all, the journey each time, and the date of validity only when the ticket had been fully used.

(4) *Birch Bros. Ltd.*, of London, printed by the *Bell Punch Co.*

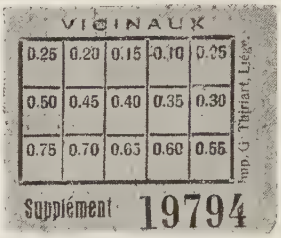


This Ticket must be produced when required.

W. to S. 1d.
W. to Bank 2d.
W. to L. 3d.
B.R. to C.S.S. 1d.
B.R. to L. 2d.
St. P.S. to L. 1d.

Please see that the correct amount is marked on the Ticket.—FARE ALL THE WAY 3d.

M3952

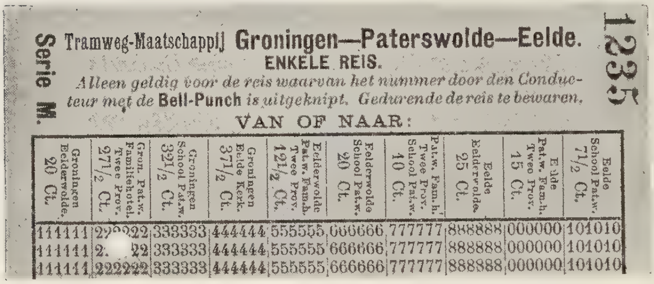


VICINAUX

0.25	0.20	0.15	0.10	0.05
0.50	0.45	0.40	0.35	0.30
0.75	0.70	0.65	0.60	0.55

Supplément 19794

Imp. G. Thiriart, Liége.



Serie M.

Tramweg-Maatschappij **Groningen—Paterswolde—Eelde.**

ENKELE REIS.

Alleen geldig voor de reis waarvan het nummer door den Conducteur met de **Bell-Punch** *is uitgeknipt. Gedurende de reis te bewaren.*

VAN OF NAAR:

Groningen Eelderwolde. 20 Ct.	Gron. Pat.w. Familiehotel. Twee Prov. 27½ Ct.	Groningen School Pat.w. 32½ Ct.	Groningen Eelde Kerk. 37½ Ct.	Eelderwolde Pat.w. Fam.h. Twee Prov. 12½ Ct.	Eelderwolde School Pat.w. 20 Ct.	Pat.w. Fam.h. Twee Prov. School Pat.w. 10 Ct.	Eelde Eelderwolde. 25 Ct.	Eelde Pat.w. Fam.h. Twee Prov. 15 Ct.	Eelde School Pat.w. 7½ Ct.
111111	2[illegible]22	333333	444444	555555	666666	777777	888888	000000	101010
111111	2[illegible]22	333333	444444	555555	666666	777777	888888	000000	101010
111111	222222	333333	444444	555555	666666	777777	888888	000000	101010

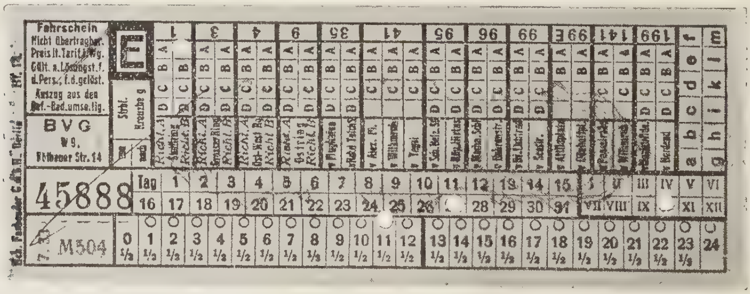
1235

Different value paper tickets. (Red. 4/5).

Fig. 218. — London horse-bus ticket of the *Railways and Metropolitan Omnibus Co. Ltd.*, about 1893 — The ends of the stage points are shown by initials.

Fig. 219. — List of fares only — *Belgian National Light Rys. Co.* — Supplement ticket.

Fig. 220. — List of routes with corresponding fares — *Tramweg Maatschappij Groningen-Paterswolde-Eelde* — Perforation in space with safety background, made up of repeated stage number.



Fahrschein
Nicht übertragbar.
Preis lt. Tarif usw.
Gült. a. Lösungst. f.
d. Pers. f. d. gelöst.
Auszug aus den
Bef.-Bed. umseitig.

BVG
W 9.
Köthener Str. 14

E

45888

M504

1 3 4 6 35 41 95 96 99 99E 141 199

A B C D

f e d c b a
m l k i h g

Tag 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

I II III IV V VI
VII VIII IX X XI XII

0 ½ 1 ½ 2 ½ 3 ½ 4 ½ 5 ½ 6 ½ 7 ½ 8 ½ 9 ½ 10 ½ 11 ½ 12 ½ 13 ½ 14 ½ 15 ½ 16 ½ 17 ½ 18 ½ 19 ½ 20 ½ 21 ½ 22 ½ 23 ½ 24

Fig. 221. — List of stage points of each line in either direction. (Red. 3/4) — Reference table on the back — Separate spaces for each direction — Control lists (month, date of month, hours and half hours) — Dated with dating stamp — Company's monogram as background — *Berliner Verkehrs Gesellschaft (Berlin Transport Company).*

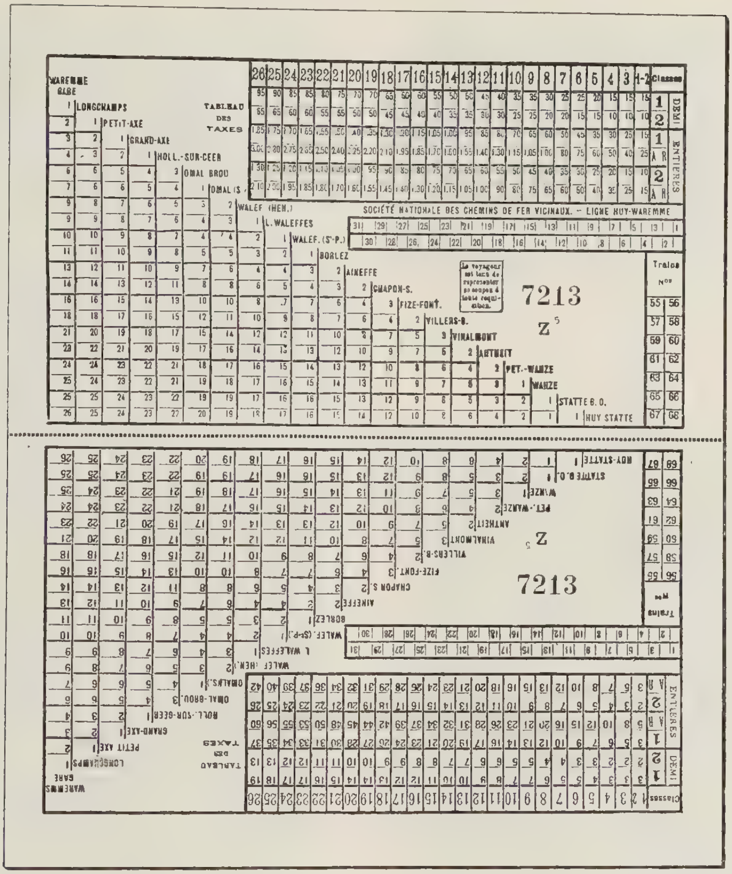


Fig. 222. — Duplex ticket — *Belgian National Light Rys. Co.* (Red. 3/4) — Reference table of stage points — Second table of fares in each class, single and return and half fares — List of days of month, and train numbers — Thiriart patent.

kets, with one or more changes en ute. Some of them are duplex paper heme tickets available from several pla- s to several destinations, with lists of res in each case (1). The list of ex- ange stations is usually printed oppo- e the list of starting points, and over ainst each of these, the lists of destin- ions are grouped according to the fare g. 224).

CONTINENTAL DUPLEX TICKETS. — As it is essential to limit the number of different tickets isued on light railway trains, duplex tickets with two lists of parameters — places and fares — are frequently used.

The oldest of them were introduced by the *Mommens Printing Works*, Brussels, which long held a monopoly in many European countries. So as to divide these

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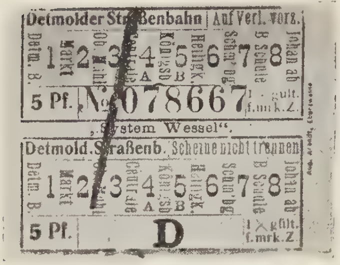
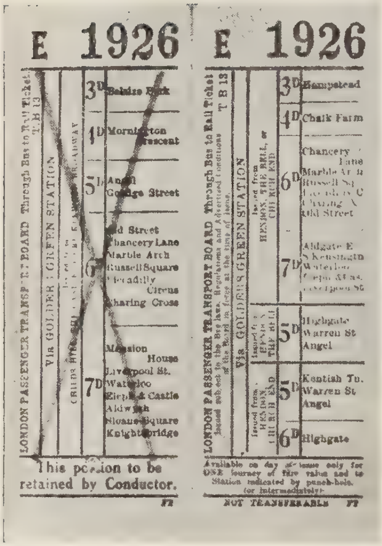
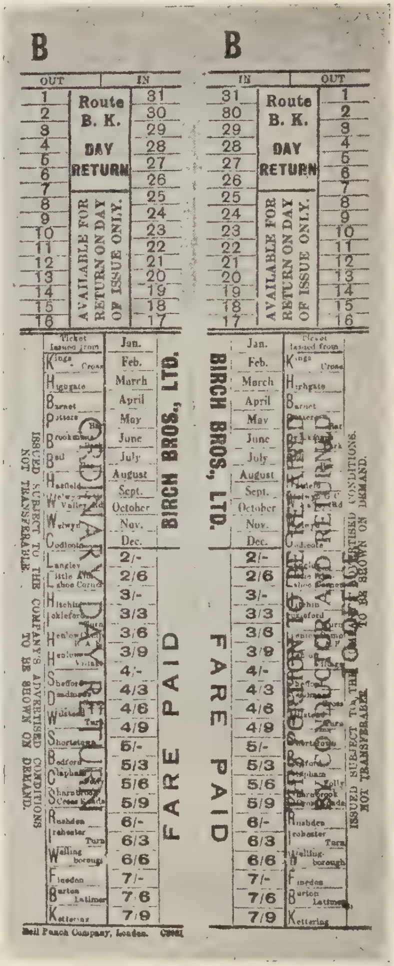
1) The *Bell Punch Co.*




E 1926
E 1926
LONDON PASSENGER TRANSPORT BOARD Through Bus to Rail Ticket
Via GOLDERS GREEN STATION
This portion to be retained by Conductor.
NOT TRANSFERABLE


B
B
OUT
IN
Route B. K.
DAY RETURN
AVAILABLE FOR RETURN ON DAY OF ISSUE ONLY.
BIRCH BROS., LTD.
FARE PAID
ORDINARY DAY RETURN
ISSUED SUBJECT TO THE COMPANY'S ADVERTISED CONDITIONS TO BE SHOWN ON DEMAND.
NOT TRANSFERABLE.
Bell Punch Company, London.

European simplex and duplex tickets. (Red. 4/5).

Fig. 223. — Wessel type simplex ticket (Detmold).

Fig. 224. — Duplex ticket — Bus ticket issued by *London Passenger Transport Board* for a through bus and rail journey — Origin and destination scheme ticket — List of journeys grouped according to route and to fares.

Fig. 225. — *Birch Bros, Ltd.* duplex ticket Return — List of stops and fares — Mont and days of month — Large stage name i tials — *Bell Punch Co.*, London.

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tickets — which included a triangular double-entry table — diagonally into two triangular parts, they were folded along their hypotenuse. The headings of the horizontal lines and columns were show as simply as possible. To head the ho zontal lines, a list of names was print each with its corresponding consecuti number next to it and, to head the columns, the same numbers were used, which saved a good deal of space (1) *(fig. 117)*.

Though duplex tickets have continuously been used for light railways, the rectangular shape has alone survived, the tickets being folded parallel to the vertical side (2). In Italy, the fares from one or two different places is frequently given beside the name of each place (3); the return tickets are triplex.

The *Thiriart Printing Works* (Liége) patented duplex tickets which differed from the above in that, besides the places-parameter, they have a categories-parameter, so that only one kind of ticket need be used. Their special feature is the way the fare is shown by means of two tables. The first table is triangular and quotes the number of stages between any two places. The list of places is stepped, so that it is needless to repeat them at the head of the columns. In the second table, which gives corresponding fares for all the categories listed in a column, the stage numbers are used as headings (4). A single perforation in the second table shows the actual journey, and the clipping in the triangular table enables the passenger to check the number of stages of his journey.

Instead of detaching duplex tickets from a block or book of tickets, in which they are bodily bound, the binding may apply to the back portion of each duplex ticket, only leaving the detachable front portion free.

This method is used by the *International Sleeping Car Company* for the Pullman supplements in certain « de luxe » trains (5); in this case the fares between all the stations served are shown in a double-entry triangular table *(fig. 426)*.

The American duplex or triplex tickets, known as cash fare receipts, are used both on the main-line trains and interurban lines when fares have to be collected during the journey. The portion known as the audit check usually bears the following words

> Not good for passage. Of no value except to the conductor.

It is retained by him while the part issued to the passenger has no other distinctive marking than a coloured band bearing the Company's name and some text. The elements of all the lists are symmetrically printed on both halves of the duplex ticket, so that they may be identically perforated at one clipping (fig. 225).

Return duplex tickets usually have a third coupon folded back on to the two others; in this way all three are perforated at one and the same time. The three coupons are printed in the flat before folding the ticket. The central portion is sometimes printed on the back, and the other two on the ticket's face; when the three parts are folded, the text is all on the same side, though in actual fact, it

---

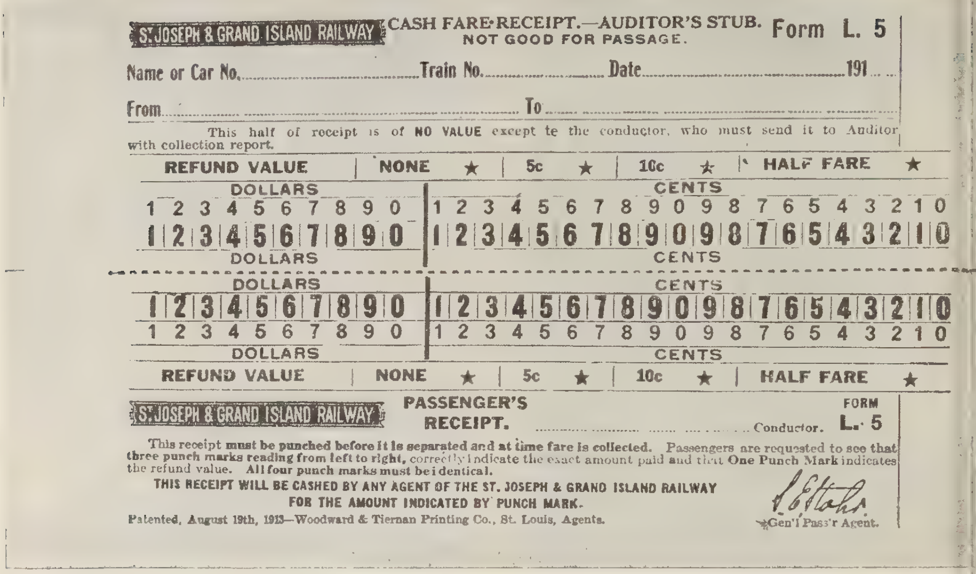
(1) A complete ticket of each kind — one a half ticket and the other a return ticket — was required for each class. In some cases, a set of different tickets was provided for the return trip. They were used on the *East-West Liége Tramways* and by the *National Light Rys. Co.* (Belgium).

(2) *Könnern-Rothenburg Kleinbahn; Bergamo-Soncino Railway.*

(3) On the *Italian Interprovincial* system, there appear in addition to the fares for single journeys, two return tariffs, one from Turin and the other from Poirino.

(4) *Vianden-Diekirch Ry.* (Luxemburg); *Belgian National Light Railways Company.*

(5) The « Etoile du Nord » (North Star) and the « Oiseau Bleu » (Bluebird).



ST. JOSEPH & GRAND ISLAND RAILWAY CASH FARE RECEIPT.—AUDITOR'S STUB. Form L. 5
NOT GOOD FOR PASSAGE.
Name or Car No. .... Train No. .... Date .... 191 ..
From .... To ....
This half of receipt is of **NO VALUE** except te the conductor, who must send it to Auditor with collection report.

REFUND VALUE	NONE ★	5c ★	10c ★	HALF FARE ★

DOLLARS — CENTS
1 2 3 4 5 6 7 8 9 0 | 1 2 3 4 5 6 7 8 9 0 9 8 7 6 5 4 3 2 1 0
1 2 3 4 5 6 7 8 9 0 | 1 2 3 4 5 6 7 8 9 0 9 8 7 6 5 4 3 2 1 0
DOLLARS — CENTS

DOLLARS — CENTS
1 2 3 4 5 6 7 8 9 0 | 1 2 3 4 5 6 7 8 9 0 9 8 7 6 5 4 3 2 1 0
1 2 3 4 5 6 7 8 9 0 | 1 2 3 4 5 6 7 8 9 0 9 8 7 6 5 4 3 2 1 0
DOLLARS — CENTS

REFUND VALUE	NONE ★	5c ★	10c ★	HALF FARE ★

ST. JOSEPH & GRAND ISLAND RAILWAY PASSENGER'S RECEIPT. .... Conductor. FORM L. 5

This receipt **must be punched before it is separated and at time fare is collected.** Passengers are requested to see that **three punch marks reading from left to right,** correctly indicate the exact amount paid and that **One Punch Mark** indicates the refund value. **All four punch marks must be identical.**

THIS RECEIPT WILL BE CASHED BY ANY AGENT OF THE ST. JOSEPH & GRAND ISLAND RAILWAY
FOR THE AMOUNT INDICATED BY PUNCH MARK.

Patented, August 19th, 1913—Woodward & Tiernan Printing Co., St. Louis, Agents.

Gen'l Pass'r Agent.

Fig. 226. — American duplex ticket. (Red. 3/4) — *St. Joseph and Grand Island Ry.* — List of dollars, dimes and cents. Spaces for perforating refund and when used fo half fare.

has been printed on the face, back and face respectively.

To accelerate perforation and to prevent mistakes, special cutters are used.

AMERICAN DUPLEX TICKETS WITH VALUE-PARAMETERS are the most frequent, as they can be used whenever a fare has to be collected during the journey. They differ by the way the fare is shown on them. This is done by a cutter, which perforates elements in three lists of figures giving the cents, dimes, dollars, and sometimes tens of dollars. This is completed by control indications concerning the rates, the date, and, if need be, the numb of passengers (1).

RETURN DUPLEX AND TRIPLEX TICKETS. — Besides the fare, the beginning and e of the journey, and the date or period validity, have to be shown.

The *Manilla R. R.* (Philippines) us duplex tickets folded along the small hor zontal side, which is exceptional. T avoid repeating the list of stations, the is, in front of it, a double vertical c lumn, one side of which is perforated the outward and the other on the retu journey (2).

---

(1) The *Burlington, Rock Island R. R.* arranges the fares in three columns. The direction (North, South, East or West) is added and there is a space for possible half-fare and luggage perforations [*Stromberg, Allen and Co.* (Chicago) type].

(2) The *International Tickets Co.* of Newark, N. J., supplies these tickets to the *Pennsylvania R. R.* The fares are printed in symmetrical horizontal lines. These tickets also show the date (1900 + the years from 31 to 38, month and day of the month, the number of passengers (2 to 5, for when there is one only, no perforation is required), besides certain rating information : half-price, ticket produced with guard's ticket, extra-fare charged by assistant, supplement exchanged for scrip.

The *Bamberger Electric R. R. Co.* uses iplex tickets on which the departure staon is clipped once, and the destination vice. A peculiar feature of these tickets that the period of validity varies, when ey are used as excursion tickets, from to 12 days, so that an additional perforion is required (1).

RESERVATION OF SEATS. — Duplex (and iplex) tickets are suitable for the purse. They all bear a list of the seats d, if need be, of the coaches in which ey are. In addition to this, there is the ual list of places served, amongst which e departure and arrival stations are perrated, a list of the resulting charges, d lists of dates. The duplex tickets metimes also have printed lists, in dolrs and cents, of the charges for luggage. is implies that a considerable number perforations have to be made; the *ichigan Central Ry.* duplex tickets are rforated in 14 places, and each succesve conductor thereafter clips what reains of it (2).

Triplex tickets are used instead of duex for accountancy purposes. The leftnd coupon is a control coupon; the cenl one, which is the actual reservation eck, is collected by the conductor, and right-hand coupon is kept by the pasnger to justify his claim to his seat. is same system is used, in a different rm, for advance bookings by the Euroan *Sleeping Car Co.*, the only differen between these and American tickets being that they are printed on a different side (3), and the information about the journey is supplied in a different way (4).

(c) INDICATIONS BY SEVERANCE.

This method requires the printing of the text and list of elements through which the ticket will be severed, to be arranged in a special way. One portion remains with the booking clerk, whereas the other is handed to the passenger. The last factor only of each part concerns the journey, and each portion of the ticket bears one of two consecutive factors of the lists.

This effectively prevents fraud, for if the passenger cuts off part of his ticket, it would show a lower value than what he has paid for. And if the booking clerk did likewise, the paper or cardboard stub would show a higher value than the one for which he has received payment, which would also be to his disadvantage.

From the last factor on the stub, the one immediately following which having been separated from it, now is on the ticket, can be easily ascertained. A simpler means consists in printing in smaller type, besides the factors of the first list, a second and less conspicuous one, in which each factor is lower by one unit than its neighbour in the first list. It is then possible to read off directly, on the stub and on the ticket, the factor concerning the journey : on the ticket as an element of the principal list, and on the stub, as one of the less conspicuous lists (1).

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(1) The months and days indications are shown by perforation, as well as the pesos and ntavos. There are also places for the conductor's and auditor's checking perforation.

(2) The date requires 3 perforations (year, month and day); the journey, 2; the train imber, 3 (hundreds, tens and units); the seat number, 1; the price, 2; and sometimes a irther perforation is needed for half fare.

(3) On the *Bessemer and Lake Erie R. R.*, the unfolded ticket is printed on one side ily, whereas on the *Fort Smith and Western R. R.* the central coupon is printed on the ther side *(Poole Bros. Printing Works*, Chicago*)*.

(4) The direction is often shown (East or West, for example).

Sectional division of Edmondson tickets. — Unlike return tickets which are divided into two portions along a specially prepared line, these have to be severed between any two factors of given lists. This is done with a pair of scissors or with specially designed cutters.

(a) The most frequently used ticket of the kind known as « talon-valeurs » has a list of all the fares for which it can be used. The cutting takes place according to the way in which these factors are arranged.

If there is only a single value on each line, the ticket is cut horizontally (fig. 230). When two figures are printed on each line, even figures on the left and odd ones on the right (2) (fig. 228), the ticket is cut horizontally in the case of odd amounts, and diagonally for even ones. When too great a number of values have to be listed, they can be printed alternately on either side of the line and the ticket will always have to be divided diagonally. The actual value is thus shown on both the passenger's portion and on the booking clerk's stub.

When there are more values, still one set of « talon-valeurs » is used up to a certain amount, and one or several others for larger ones.

In order to reduce its stock of tickets, the *Belgian National Rys. Co.* now uses, in its *A. E. G.* machines, tickets with percentage-stubs of a special type havi above the full fare, a list of all the p centages in force (fig. 231). To indic the fare charged, the ticket is section horizontally between two consecutive p centages. This is done in a special cut provided with a series of slots of dif rent depths each of which corresponds the amount to be cut off for one of percentages shown on the ticket.

Sometimes, as on the *Italian State R* (fig. 230) and the French *Est* (figs. 2 to 235), the stub is not as wide as t ticket. It then has to be clipped twi once vertically down to one of the fact on the fares list, and once horizonta The length of the first cut varies, that the second one does not.

The latter Railway has special cont vances for punching out the stubs. Italy, on the other hand, the tickets a slotted to the maximum depth befo hand, so that short horizontal cuts o are required to detach the stub (3).

The Willebrew Ticket System (marketed by Alfred Williamson and troduced by the *Ribble Motor Services*, an adaptation to British conditions of t Continental « billet à talon-valeurs with the extra characteristic of snippi off a strip 15 mm. (5/8" wide), whi remains in the body of the punch as the confetti in the ordinary *Bell Pun* machine (fig. 229).

The tickets made of soft card are mm. (1 5/8") wide, the length rangi from 97 to 125 mm. (3 13/16" to 5") (

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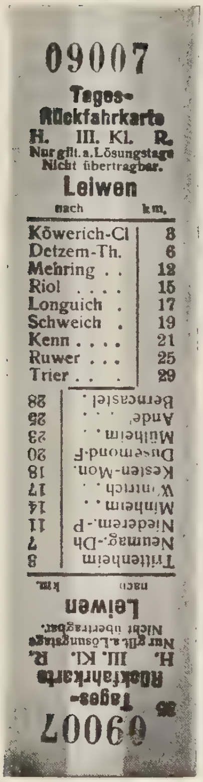
(1) To distinguish the two lists, the second may be printed upside down, or the figu res of the second arranged perpendicularly to the first. Or else the first list may consis of letters, and the second of figures, or vice-versa.

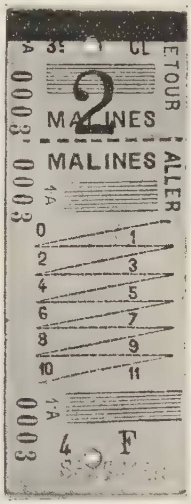
(2) *Belgian State Rys.*

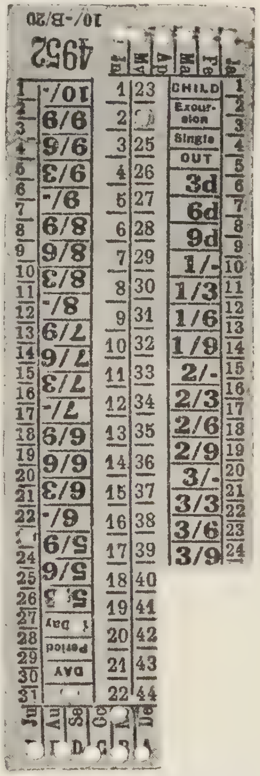
(3) The lire are shown in the first column, the centisimi, in the second.

(4) English patent No. 321 939.

(5) Used by *H. Brown and Son* and the *East Yorkshire Motor Services Ltd.* and other besides the *Ribble Motor Services.*







Tickets with various kinds of stubs. (Red. 4/5).

ig. 227. — Return ticket with place or distance stub.

ig. 228. — « Talon-valeurs » return ticket — *Belgian State Rys.* — Period of validity overprinted in red, the return half being also overprinted with a red band — Alternate horizontal and diagonal severance — Destination « grid ».

ig. 229. — *Willebrew* ticket with value stub punched out — Printed with list of stage points, and the month and days of the month.

ey are preprinted simplex tickets availle for a number of different fares. Thee are written specially in two columns, e with numbers facing downwards, the ier with the numbers facing the other y. The number of the ticket is reproced at the bottom of each column. hen a fare has to be paid, the conduc- inserts the ticket in the cutter, the ial number first, up to the required division and presses a side lever which snips off the strip bearing the serial number and all prices up to, but not including, the fare paid. This strip is preserved by him in the punch itself and the remainder (having the second printing of the same serial number) handed to the passenger.

A single type of ticket easily bears all fares from 1 d., up to 3 sh. 4 d., and if

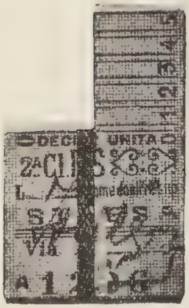


Fig. 230. — Slotted ticket with value stub — (Red. 4/5) — *Italian State Rys.* — Two columns of values, one for units, the other for tens — Printed on a safety background of black or grey crossed lines.

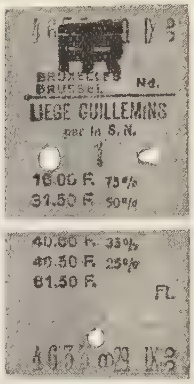


Fig. 231. — Ticket with percentage stub used in *A. E. G.* machines of the *Belgian National Rys. Co.* — Interwoven initials of return tickets previously printed in red.

other types are carried, fares up to much higher figures can be obtained with little trouble.

Apart from the fare indication, which is the characteristic of the Willebrew system, the ticket bears a number of others, from which the conductor chooses the ones he must nip with hand nippers. Thus, along a central line, the number of each stage is reproduced. On either side of the ticket are the dates, at the top and bottom, the names of the months, in one corner, the words « inward » or « outward », and in another, the category (« child » or « excursion »).

Finally, there are many means of using full-fare as HALF-FARE children's tickets. Many railways punch out square, triangular or even half-circle fragments bearing the name of the destination and number of the issuing stations (figs. 165, 236 and 237). This kind of stub makes f easy checking.

Sectional division of paper tickets. These tickets, easier to sever than are t Edmondsons, are used on both light a main-line railways, though « value par meter stub tickets » are more usual the latter. All possible values are som times given in arithmetical progressio or certain values only are listed. In oth instances, only the rate at which t values increase is repeated a certain nu ber of times.

These paper tickets are perforated b tween each and every factor of the seri which makes it convenient to detach a portion of them (figs. 238 to 240).

There are different single and retu tickets of each class. Some of them mere give the fares; the names of the departu and arrival stations have to be added hand (1).

Paper « talon-valeurs » tickets are fr quently used for supplements charged the train (2). When there are differe amounts, this is not convenient, even several different « talon-valeurs » ticke each covering a different part of the li of possible charges, are used.

The system has therefore been altere The amounts to be paid are made up francs and centimes (or money of a other currency) the former being listed one column and the latter in anoth This raises another problem : how to vide the ticket into two portions corr ponding with the total amount require This has been done by partly slitting the ticket beforehand between the c lumns along one, two or even three ve tical lines. It thus becomes easy to divi it rapidly by small horizontal cuts. T system is widely used in Italy (f

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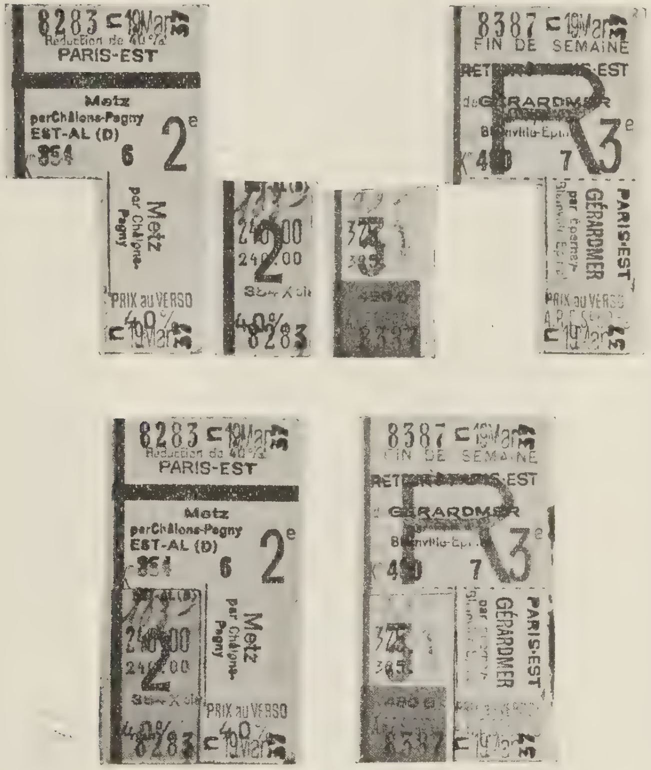
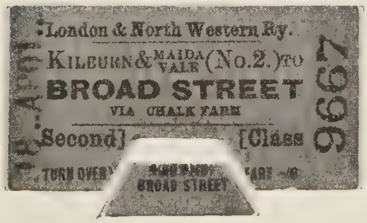
(1) *Tramways de l'Indre.*

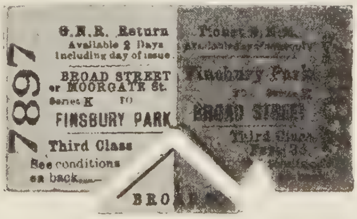
(2) French *Nord Railway; Netherlands Railways.*



French *Est Ry.* tickets used in *A. E. G.* machines
with the stubs punched out by cutters. (Red. 4/5).

Gigs. 232 and 233. — Single and return tickets, with punched out stubs.
Figs. 234 and 235. — The same tickets before cutting out the stubs.

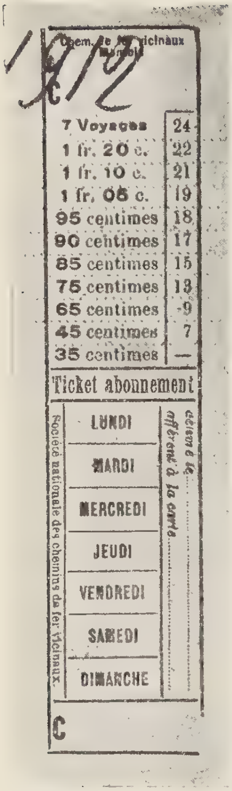




Stubs punched out of English tickets so as to render them available for children.
(Red. 4/5) — The number of issuing and name of destination station are shown on the stub.

ig. 236. — *London and North Western Ry.*
Single ticket.

Fig. 237. — *Great Northern Ry.*
Return ticket.



1912

Chem. de [illegible] vicinaux

7 Voyages	24
1 fr. 20 c.	22
1 fr. 10 c.	21
1 fr. 05 c.	19
95 centimes	18
90 centimes	17
85 centimes	15
75 centimes	13
65 centimes	9
45 centimes	7
35 centimes	—

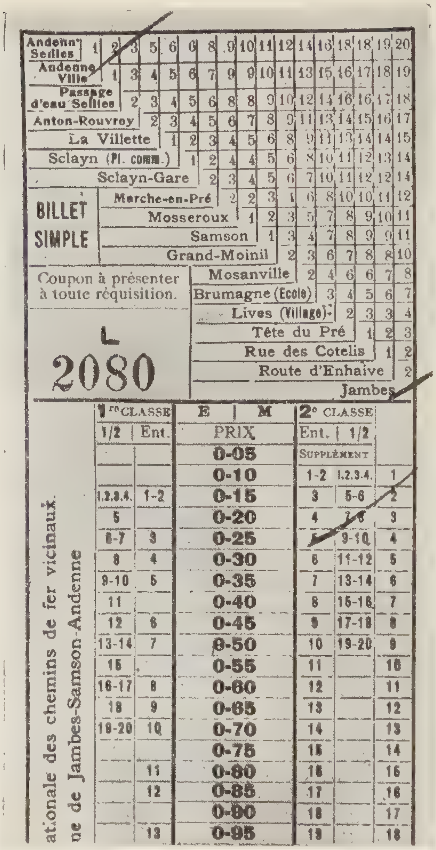
Ticket abonnement

Société nationale des chemins de fer vicinaux.

LUNDI
MARDI
MERCREDI
JEUDI
VENDREDI
SAMEDI
DIMANCHE

délivré le............ afférent à la carte............

C



Andenne Seilles	1	2	3	5	6	6	8	9	10	11	12	14	16	18	18	19	20
Andenne Ville		1	3	4	5	6	7	9	9	10	11	13	15	16	17	18	19
Passage d'eau Seilles			2	3	4	5	6	8	8	9	10	12	14	16	16	17	18
Anton-Rouvroy				2	3	4	5	6	7	8	9	11	13	14	15	16	17
La Villette					1	2	3	4	5	6	8	9	11	13	14	14	15
Sclayn (Pl. comm.)						1	2	4	4	5	6	8	10	11	12	13	14
Sclayn-Gare							2	3	4	5	6	7	10	11	12	12	14
Marche-en-Pré								2	2	3	4	6	8	10	10	11	12
Mosseroux									1	2	3	5	7	8	9	10	11
Samson										1	3	4	7	8	9	9	11
Grand-Moinil											2	3	6	7	8	8	10
Mosanville												2	4	6	6	7	8
Brumagne (Ecole)													3	4	5	6	7
Lives (Village)														2	3	3	4
Tête du Pré															1	2	3
Rue des Cotelis																1	2
Route d'Enhaive																	2
Jambes																	

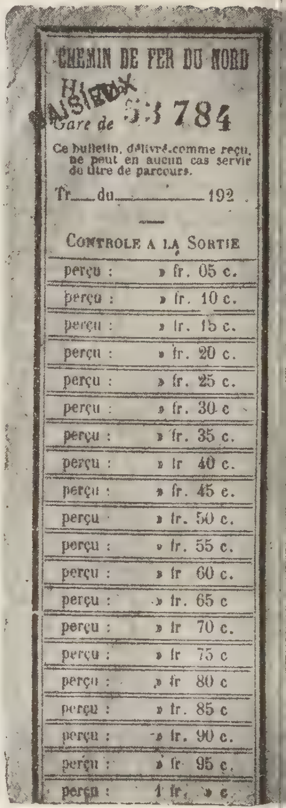
BILLET SIMPLE

Coupon à présenter à toute réquisition.

L
2080

...ationale des chemins de fer vicinaux.
...ne de Jambes-Samson-Andenne

1re CLASSE 1/2	1re CLASSE Ent.	E | M PRIX	2e CLASSE Ent.	2e CLASSE 1/2	
		0-05	SUPPLÉMENT		
		0-10	1-2	1.2.3.4.	1
1.2.3.4.	1-2	0-15	3	5-6	2
5		0-20	4	7-8	3
6-7	3	0-25	5	9-10	4
8	4	0-30	6	11-12	5
9-10	5	0-35	7	13-14	6
11		0-40	8	15-16	7
12	6	0-45	9	17-18	8
13-14	7	0-50	10	19-20	9
15		0-55	11		10
16-17	8	0-60	12		11
18	9	0-65	13		12
19-20	10	0-70	14		13
		0-75	15		14
	11	0-80	16		15
	12	0-85	17		16
		0-90	18		17
	13	0-95	19		18



CHEMIN DE FER DU NORD

Gare de [illegible] 53784

Ce bulletin, délivré comme reçu, ne peut en aucun cas servir de titre de parcours.

Fr.____ du________________192 .

CONTROLE A LA SORTIE

perçu :	» fr. 05 c.
perçu :	» fr. 10 c.
perçu :	» fr. 15 c.
perçu :	» fr. 20 c.
perçu :	» fr. 25 c.
perçu :	» fr. 30 c
perçu :	» fr. 35 c.
perçu :	» fr 40 c.
perçu :	» fr. 45 c.
perçu	» fr. 50 c.
perçu :	» fr. 55 c.
perçu :	» fr 60 c.
perçu :	» fr. 65 c
perçu :	» fr 70 c.
perçu :	» fr 75 c
perçu :	» fr 80 c
perçu :	» fr. 85 c
perçu :	» fr. 90 c.
perçu :	» fr 95 c.
perçu :	1 fr. » c.

Paper tickets with talons-valeurs (values-scale stub). (Red. 3/4).

Fig. 238. — Weekly ticket for 7 return trips — *Belgian National Light Rys. Co.* — List of actual fares and list of number of 5-centime stages.

Fig. 239. — Blank ticket issued by same Company — Double entry reference table of the number of sections and common headings for lines and columns — Scale of fares and columns showing the number of corresponding stages for various classes or categories.

Fig. 240. — Supplement ticket — French *Nord Ry.* — No other indication than the amount charged.

241) (1), not only in the case of « talon-valeurs », but for any other lists as well (2).

The slits are generally straight. We have only come across a single instance of actual perforation between the co-

---

(1) On the right-hand side of the blank tickets, there is a large stub and on the left, a scale of values arranged perpendicularly and divided into two columns. The arrangement is used on various kinds of season tickets.

(2) The list of fixed charges and identity taxes together with the corresponding amounts, is also shown in two columns of slotted tickets.

mns, and this on a light railway (1).
ıe same idea has been applied to blank
·kets on the *P.O.-Midi;* wide slits sepa-
te the columns of hundreds, tens and
its of francs (fig. 280).

In the States, « talons-valeurs » of this
pe are used in connection with special
tters, the vertical slits being rectangular
oval in shape.

TANGEMAN'S PATENT TICKETS (2) have a
ıgle slit with list of dollars on one side,
d of cents on the other. An auxiliary
t, in which the amounts are one unit
wer, accompanies each of these lists.
ıese tickets are even used for auxiliary
rvices such as cloakroom charges (3);
addition to the parts held by the pas-
nger and the auditor, there is a third
rtion for the cloakroom clerk.

When there are two slits, both are
raight (4) or oval (fig. 242). Sometimes,
stead of a progressive list of cents, the
st column consists of a given number of
nts indefinitely repeated (5).

The *Lake Erie and Western R. R.* has
o-slot tickets (6) which entitle the hold-
to a refund within a period of 6
onths. For this purpose, each of the
ee columns of progressive values (dollars, dimes and cents) is subdivided into sub-columns showing on the right, the amount to be refunded. It required much ingenuity to print all this clearly, as the lists themselves are doubled by the usual auxiliary lists of amounts one unit lower each.

Other tickets with two vertical oval slots include (7) or do not include (8) such auxiliary lists. This also applies to three-slot tickets (9).

The *Kansas City and Southern R. R.* and the *Texarkana and Fort Smith R. R.* interline tickets have two control stubs, one for each company (fig. 242).

The REID PATENT TICKETS are very similar.

The RUMANIAN STATE RYS. alone, we believe, use blank paper « talons-valeurs — with two distinct sets of parameters and zigzag divisions similar to those of Edmondson tickets. Four perpendicular columns on the left-hand side of the ticket show the values in thousands, hundreds, tens and units of leis; in addition, there is a class-list across the entire width of the body of the ticket (10).

OTHER KINDS OF TICKETS. — These me-

---

(1) Lyons-La Balme line. These tickets could be used in either of the two classes.

(2) Patent granted the 28th July, 1891. Agents, *Woodward and Tiernan Printing Co.*
sed by the *Litchfield and Madison Ry. Co.* and the *Kanaha and West Virginia R. R.*

(3) *Cincinnati Northern R. R.*

(4) *Southern Pacific R. R.*

(5) *Texas and Pacific Ry. Co.*

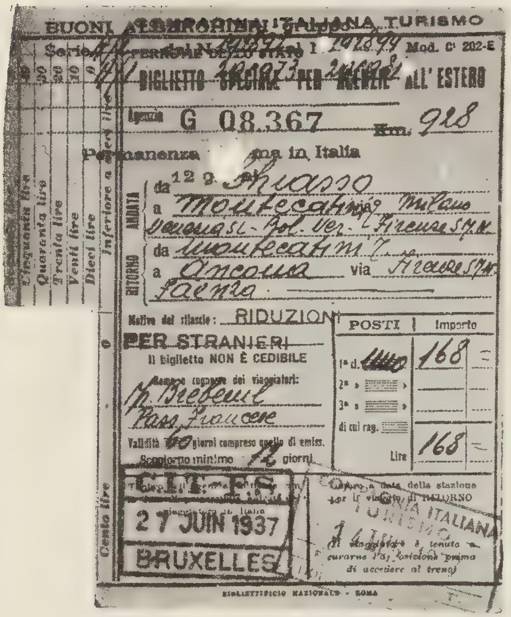
(6) *Woodward and Tiernan Printing Co.* Like all refund tickets, they include lists
months and days.

(7) *Kansas City Southern R. R.*

(8) *Illinois Central R. R.*

(9) Patent granted the 6th December, 1892. *Rand, MacNally and Co.*, owners of the
tent. Used by the *International Great Northern R. R.* The vertical slot is oval and
ere is a stub for the collector.

10) The same indications are repeated to the right and left of each of the 5 series by
e *Rumanian State Rys.* Diagonal severance allows the same wording to be used on the
ket and its stub.



BUONI ALBERGHIERI ITALIANA TURISMO

Serie — FERROVIE DELLO STATO — Mod. Cᴵ 202-E

BIGLIETTO SPECIALE PER AGENZIE ALL'ESTERO

Agenzia G 08.367 Km. 928

Permanenza minima in Italia

ANDATA da 12 g. Chiasso

a Montecatini via Milano

Varenna S. L.-Bol. Ver. - Firenze S. M. N.

RITORNO da Montecatini T.

a Ancona via Firenze S. M. N.

Faenza

Motivo del rilascio: RIDUZIONI PER STRANIERI

Il biglietto NON È CEDIBILE

Nome e cognome dei viaggiatori:

M. Brebeuf

Pass. Francese

Validità 60 giorni compreso quello di emiss.

Soggiorno minimo 12 giorni

POSTI	Importo
1ª cl. uno	168 —
2ª »	
3ª »	
di cui rag.	
Lire	168 —

C.I.T.—F.S.

27 JUIN 1937

BRUXELLES

Timbro a data della stazione per il viaggio di RITORNO

COMPAGNIA ITALIANA TURISMO

Il viaggiatore è tenuto a curarne l'apposizione prima di accedere al treno

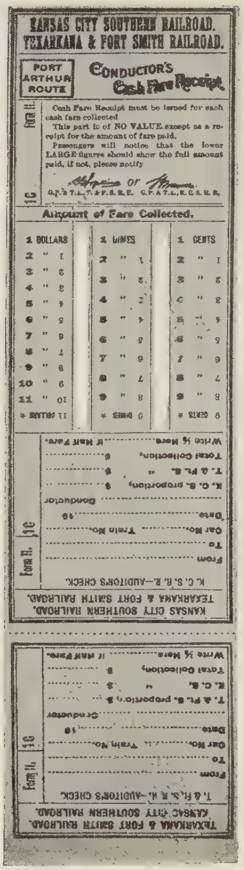
Cinquanta lire — Quaranta lire — Trenta lire — Venti lire — Dieci lire — Inferiore a dieci lire — Cento lire

BIGLIETTIFICIO NAZIONALE - ROMA

Fig. 241. — Slotted blank ticket with two scales. (Red. 3/4) — *Italian State Rys.* Special ticket issued by official Agency.

thods also apply to factors other than values. They have been used in connection with *lists of places* (fig. 226) or of *distances*, but as the latter correspond, in a given class and category, to certain fares, these lists are, in fact and under a different appearance, the same as the lists of values. Distances are even occasionally shown side by side with the corresponding values in the lists (¹).

It is different with the list of classes, which some railways provide either in blank or by printing each class in a different colour (fig. 243) (²).



KANSAS CITY SOUTHERN RAILROAD.
TEXARKANA & FORT SMITH RAILROAD.

PORT ARTHUR ROUTE

CONDUCTOR'S Cash Fare Receipt.

Form 11. 1C

Cash Fare Receipt must be issued for each cash fare collected.

This part is of NO VALUE except as a receipt for the amount of fare paid.

Passengers will notice that the lower LARGE figures should show the full amount paid, if not, please notify

G. P. & T. A., T. & F. S. R. R. G. P. & T. A., K. C. S. R. R.

Amount of Fare Collected.

1 DOLLARS	1 DIMES	1 CENTS
2 "	2 "	2 "
3 "	3 "	3 "
4 "	4 "	4 "
5 "	5 "	5 "
6 "	6 "	6 "
7 "	7 "	7 "
8 "	8 "	8 "
9 "	9 "	9 "
10 "		
11 "		

Write ½ Here If Half Fare.

Total Collection, $

T. & Ft. S. " $

K. C. S. proportion, $

Conductor

Date 19

Car No. Train No.

To

From

K. C. S. R. R.—AUDITOR'S CHECK.

KANSAS CITY SOUTHERN RAILROAD.
TEXARKANA & FORT SMITH RAILROAD.

Form 11. 1C

Write ½ Here If Half Fare.

Total Collection, $

K. C. S. " $

T. & Ft. S. proportion, $

Conductor

Date 19

Car No. Train No.

To

From

T. & Ft. S. R. R.—AUDITOR'S CHECK.

KANSAS CITY SOUTHERN RAILROAD.
TEXARKANA & FORT SMITH RAILROAD.

Fig. 242. — Slotted ticket. (Red. 1/2) *Kansas City Southern R. R.* and *Texark and Fort Smith R. R.* — Conductor's bla cash fare receipt — Three columns show the fare — This interline ticket shows p tion of fare allocated to each Company Check coupon for auditor of each of railways concerned.

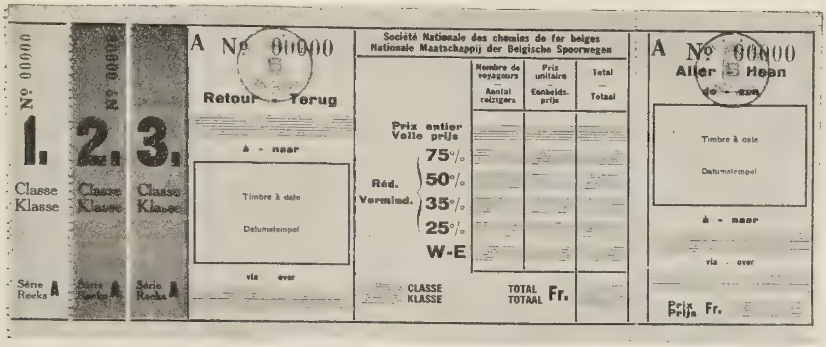
The railway Companies also use sim ler forms of tickets for different CATE RIES OF PASSENGERS. So as to enable bo

---

(¹) The *Frankfurt (M)-Königstein Light Railway* tickets show the extent of the autho rised zone of travel opposite each of the corresponding values.

(²) The stub bearing these indications is on the left side. There are two types, o for single, and one for return tickets respectively.

On the *Nord-Belge* the class list is in the middle of the ticket, and the stub repeatin all the indications given, on the part held by the passenger, at the other end.



Nº 00000 1. Classe Klasse Série Reeks A

Nº 00000 2. Classe Klasse Série Reeks A

3. Classe Klasse Série Reeks A

A Nº 00000

Retour - Terug

à - naar

Timbre à date

Datumstempel

via over

Société Nationale des chemins de fer belges
Nationale Maatschappij der Belgische Spoorwegen

	Nombre de voyageurs — Aantal reizigers	Prix unitaire — Eenheidsprijs	Total — Totaal
Prix entier Volle prijs			
Réd. Verminder. 75%			
50%			
35%			
25%			
W-E			
CLASSE KLASSE		TOTAL TOTAAL Fr.	

A Nº 00000

Aller - Heen

de - van

Timbre à date

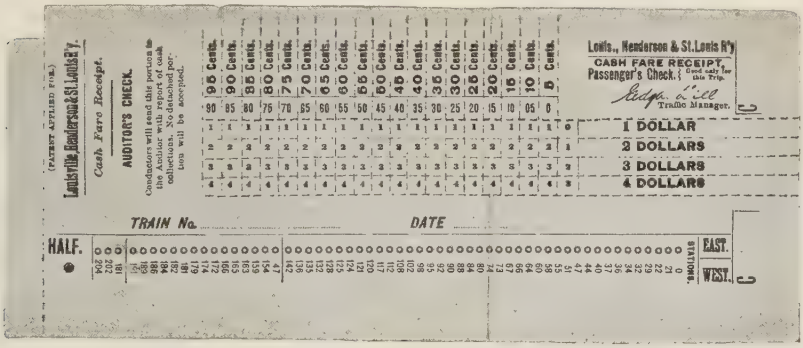
Datumstempel

à - naar

via - over

Prix Prijs Fr.

Fig. 243. — *Belgian National Rys. Co.* — Return blank ticket with a stub for the outward journey and class-scale parameter; the classes in various colours. (Red. 1/2) — Double-entry table for number of passengers and various percentages of fare reductions — Company's coat of arms overprinted in a fifth colour.



(PATENT APPLIED FOR.)

Louisville, Henderson & St. Louis R'y.

Cash Fare Receipt.

AUDITOR'S CHECK.

Conductors will send this portion to the Auditor with report of cash collections. No detached portion will be accepted.

95 Cents. 90 Cents. 85 Cents. 80 Cents. 75 Cents. 70 Cents. 65 Cents. 60 Cents. 55 Cents. 50 Cents. 45 Cents. 40 Cents. 35 Cents. 30 Cents. 25 Cents. 20 Cents. 15 Cents. 10 Cents. 5 Cents.

90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 05 0

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1 DOLLAR
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2 DOLLARS
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3 DOLLARS
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	4 DOLLARS

Louis., Henderson & St. Louis R'y

CASH FARE RECEIPT,
Passenger's Check. { Good only for this Trip.

Edgar Gill
Traffic Manager.

TRAIN No. DATE

HALF. ●

204 202 181 [illegible] 189 186 184 182 181 179 174 172 166 165 163 159 154 147 142 136 135 132 128 125 124 121 120 117 112 108 102 98 95 92 90 88 84 80 74 73 67 66 64 60 58 55 51 47 44 40 37 36 34 32 29 22 21 0 STATIONS.

EAST.

WEST.

Fig. 244. — Ticket with perforated crossed-scales table. (Red. 1/2) — *Louisville Henderson and St. Louis Ry.* — List of station numbers — Spaces for directions and half-fare perforations.

ets of detachable leaflets to be sold at alf instead of full fare, a special con-ol coupon is removed from one of the aflets.

Certain urban or interurban American nes have a SCALE OF HOURS for use with *oron* (1) or the *Globe Ticket Co.*'s cut-rs, drawn up along the same principles igs. 245-246).

Crossed scale tickets. — All the tickets we have mentioned so far apply the same principles : division into two parts between two factors in the list. That is to say they all have a single parameter.

Others have double-entry tables. Were it possible to part them so as to divide them into two parts taking into account both the vertical and horizontal lists in these tables, it would be as if severing took place between consecutive elements of two parameters. This has been accomplished in two different ways : either by the simple physical realisation of a cross division, or by using an ingenious invention called the notch perforation cutter, brought out by the *Globe Ticket Co.*, of Philadelphia.

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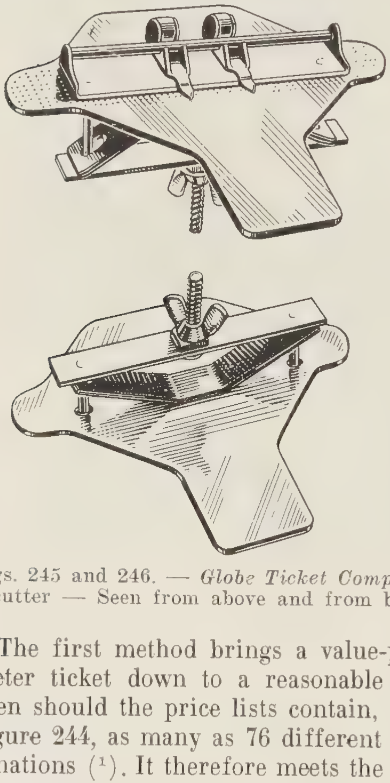
(1) *New York and Queens Transit Corporation.* The patent is dated the 28th October, 1924.



Figs. 245 and 246. — *Globe Ticket Company's* cutter — Seen from above and from below.

The first method brings a value-parameter ticket down to a reasonable size, even should the price lists contain, as in figure 244, as many as 76 different combinations (¹). It therefore meets the same desiderata as multiple-slot tickets.

The ticket is printed with a double-entry table, wherein red perforated vertical and horizontal lines take the place of the usual ones. The headings of the columns are amounts increasing by 5 cents up to 95, and those of the horizontal lines dollars; any combination is therefore easy to make up (²). The journey is shown by perforation of the departure and destination stations, and the corresponding fare is perforated in the table.

The NOTCH PERFORATION CUTTER gets the same results in a more practical way (figs. 245 and 246) and embodies the physical realisation of a very simple idea. I is, in fact, easy to sever a ticket between two consecutive factors of one list. If then the pad of tickets is inserted in a holder all that need be done to detach one o them is to pull it upwards and press i sideways against the edge of the holde and it will tear off at the selected place

The notch cutter actually works in virtual double-entry table, whose column extending down the length of the ticke have their own headings, but whose horizontal lines (here extending crosswis through the tickets) do not exist, save on of them, when the cutter is placed in position along the factor where the ticke must be severed.

With this object in view, the cuttin bar has been fitted with two notch cutters. If they are not required, they ar slipped to the extreme ends of the ba where they remain inoperative. But when in addition to simple tear-off, additiona information is to be shown on the transfer, the notching cutters come into use The transfer shows as many longitudina columns in its tear-off portion as ther are variations in the information requi ed. Each column has its heading at th end of the tear-off section.

The horizontal line factors are usuall the hours of the day and their subdiv sions (figs. 247 and 249); the pad ma

---

(¹) *Louisville, Henderson and St. Louis Ry.*

(²) The headings are doubled by an auxiliary series, each element of which is one unit lower.

e slipped obliquely inside the holder so s to indicate any number of minutes. Occasionally, the factors consist in a list of onnecting services or of places (fig. 250).

Indication by notching may be resorted o for a multitude of reasons, for instance o indicate :

Direction of travel, such as In or Out, or lse, North or South;

The route;

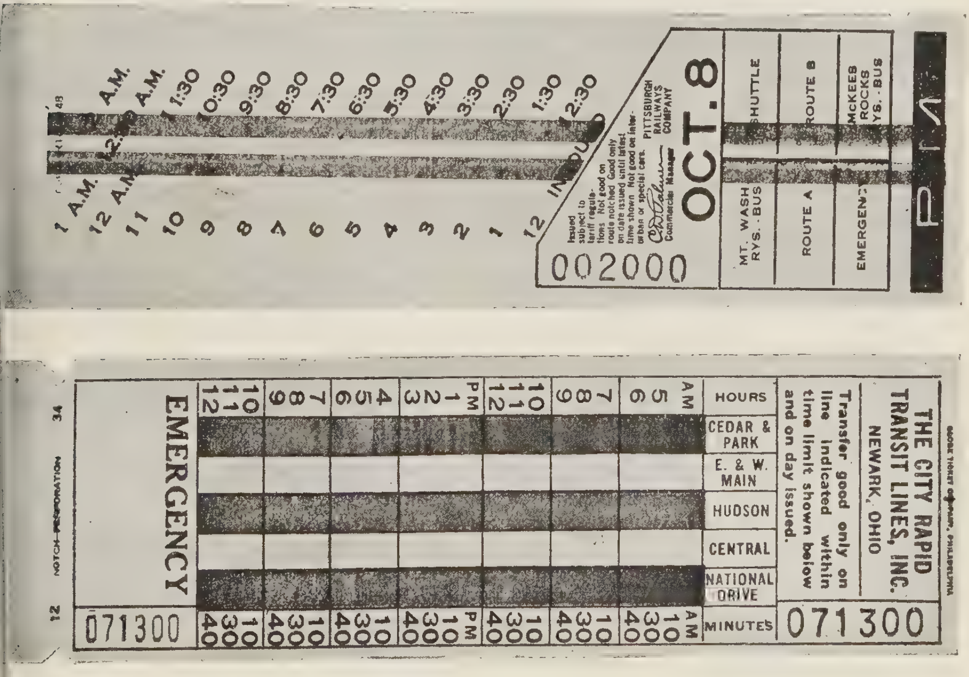
Part of date, such as month;

Zone from and to, in case of zone fare system;

Whether the transfer is issued upon receipt f cash fare or ticket fare.

When notching is required, the operator places the notching cutter into cutting position over the desired column. By first lifting the uppermost transfer under slight tension, he allows the triangular notching point to cut into the transfer. By a subsequent sideways motion the remaining cut, along the edge of the main cutting bar, is then completed.

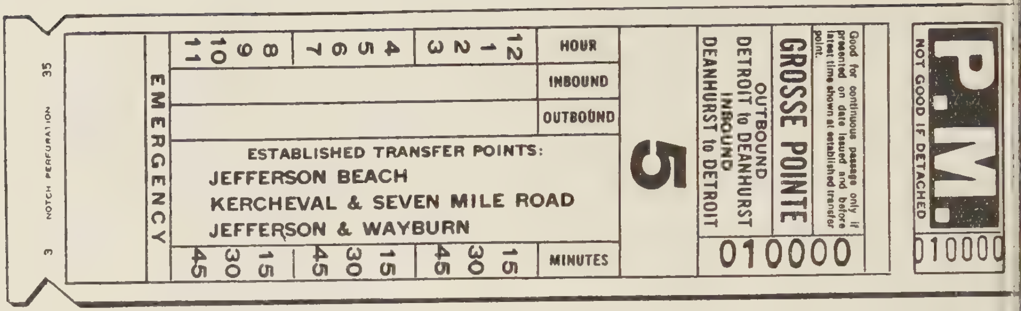
When supplementary fares are charged on certain classes of transport (such as motorbus) and not others (tram or subway), it becomes necessary to check whether a ticket has been issued on one or other of them. A particularly ingenious device makes this possible. The holder's indices are, in this case, fitted on the top, whereas the plain underside of the holder is at the back of the pad. According

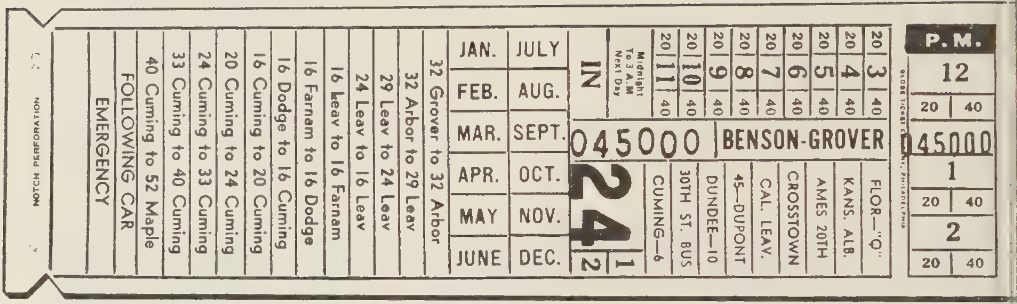


Notch perforation American scale transfers. (Red. 3/4).

ig. 247. — Oblique list of hours and half hours — *Pittsburgh* — P. M. coupon.

ig. 248. — Virtual cross scales of hours and minutes, and of lines — *The City Rapid Transit Lines*, Newark, Ohio — Alternate dark and light columns.


NOTCH PERFORATION
EMERGENCY
HOUR
INBOUND
OUTBOUND
ESTABLISHED TRANSFER POINTS:
JEFFERSON BEACH
KERCHEVAL & SEVEN MILE ROAD
JEFFERSON & WAYBURN
MINUTES
5
GROSSE POINTE
OUTBOUND DETROIT to DEANHURST
INBOUND DEANHURST to DETROIT
Good for continuous passage only if presented on date issued and before latest time shown at established transfer point.
010000
P.M.
NOT GOOD IF DETACHED



Notch perforation, American transfers. (Red. 3/4) — Detachable P. M. coupons.

Fig. 249. — Virtual cross-scales of hours and minutes, and of direction and exchange points.

Fig. 250. — Virtual cross-scales of connections, and of months — Hours and minutes in the body of the transfer.

to whether a supplement is needed or not, the ticket is torn off the upper or the lower part of the pad, thus either being notched or not (figs. 251 and 252).

We have discussed this question of transfers rather fully, because it is of considerable importance in America. Several monthly reviews are exclusively devoted to them. Moreover, by carefully choosing the transfer system best suited to their requirements, railways have been able to increase their receipts by as much as 20 %. We shall return to this important question further on.

Compared with duplex, SIMPLEX TICKET which are widely used in the States an Canada, but hardly at all in Europe (1 are more simple but need cash-fare cu ters which snip them in such a way th a projection is left on the ticket and corresponding notch on the stub (fig 253-254). The projections show which i dications apply to the journey, and a examination of the factors left on eac side of the stub's notches shows whic factors have been selected. The first c these cutters were made by the *Stromber Co.*, and the operation was known

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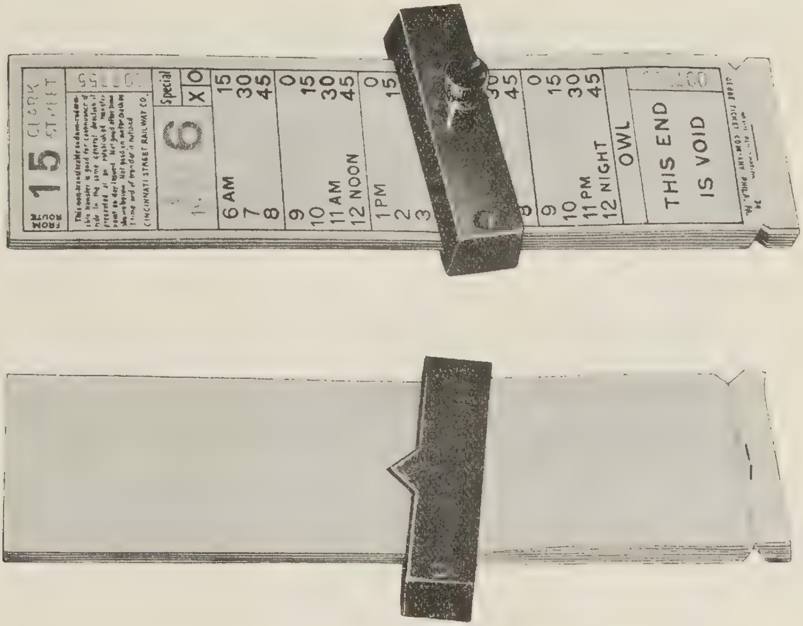
(1) Duplex tickets of the *Wessel* type supplied by *Aug. Arendt*, of Eberswalde, were used at Detmold (fig. 223).



Figs. 251 and 252. — Double-purpose cutter for issuing « transfers » from either the top or bottom of the pads.

stromberging » a ticket. It was done folding the ticket in the holder like duplex ticket and after « stromberging » pulling out the passenger's part, the st remaining in the cutter as a check.

All simplex systems apply to both kets with lists of values only, and to ose having, besides, lists of equivalent stances or of routes. We will rapidly view these types; detailed descriptions the most interesting of them will be ven in the appendix.

The notched values-scale stubs bear :

list of dollars,
list of dimes,
list of cents,

each of which goes from 0 to 9 and is doubled by an auxiliary list in less conspicuous type. The cutter leaves a projection with only one figure on it, so that the sum total is easily read in each of the three lists. At the same time, the cutter operates in the same way on any other list that may be printed on the ticket.

BLANCHARD'S PATENT TICKETS (1) have no special features. When the passenger is entitled to a refund, a duplex stub is added along the long side and a second series of symmetrical lists of dollars, dimes and cents, is appended (2).

The JOSLIN PATENT HOLDER TICKETS (3),

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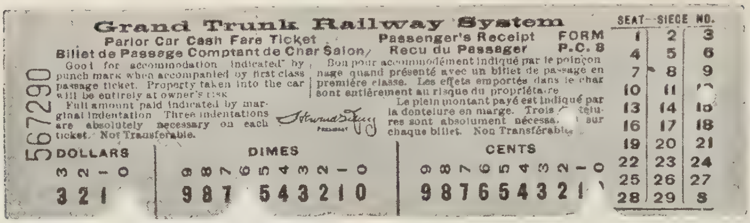
(1) *Blanchard*'s patent tickets are used by the *Cadiz R. R. Co.*

(2) *The Chicago, Rock Island and Pacific Ry.*

(3) *Joslin* patent tickets are supplied by the *Woodward and Tiernan Printing Co.*, . Louis.



Grand Trunk Railway System

Parlor Car Cash Fare Ticket — Passenger's Receipt — FORM P.C. 8

Billet de Passage Comptant de Char Salon — Recu du Passager

Good for accommodation indicated by punch mark when accompanied by first class passage ticket. Property taken into the car will be entirely at owner's risk

Full amount paid indicated by marginal indentation. Three indentations are absolutely necessary on each ticket. Not Transferable.

Bon pour accommodément indiqué par le poinçon nage quand présenté avec un billet de passage en première classe. Les effets emportés dans le char sont entièrement au risque du propriétaire

Le plein montant payé est indiqué par la dentelure en marge. Trois tetures sont absolument nécessa sur chaque billet. Non Transférable.

President

567290

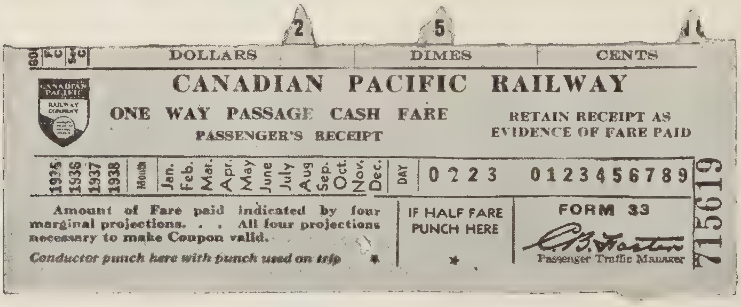
DOLLARS 3 2 1 0 — 3 2 1

DIMES 9 8 7 6 5 4 3 2 1 0 — 9 8 7 5 4 3 2 1 0

CENTS 9 8 7 6 5 4 3 2 1 0 — 9 8 7 6 5 4 3 2 1

SEAT — SIEGE NO.

1	2	3
4	5	6
7	8	9
10	11	
13	14	15
16	17	18
19	20	21
22	23	24
25	26	27
28	29	S



DOLLARS — DIMES — CENTS

CANADIAN PACIFIC RAILWAY

ONE WAY PASSAGE CASH FARE

PASSENGER'S RECEIPT

RETAIN RECEIPT AS EVIDENCE OF FARE PAID

1935 1936 1937 1938 Month Jan. Feb. Mar. Apr. May June July Aug Sep. Oct. Nov. Dec. DAY 0 2 2 3 0 1 2 3 4 5 6 7 8 9

Amount of Fare paid indicated by four marginal projections. All four projections necessary to make Coupon valid.

Conductor punch here with punch used on trip

IF HALF FARE PUNCH HERE

FORM 33

C. B. Foster

Passenger Traffic Manager

715619

« Stromberged » simplex tickets. (Red. 3/4).

Fig. 253. — *Grand Trunk Railway System* — Pullman car bilingual supplement — Li of dollars, dimes and cents — Table of seat numbers.

Fig. 254. — *Canadian Pacific Ry.* — Fare collected during the journey — Year, mont and day; the latter indicated by combination of two perforated figures.

based on the same principles, often include, after the list of fares, additional indications such as a series of dates (year, month and day) (1) or list of categories. The part kept by the booking clerk also gives a list of departure stations (2).

The DOUBLE CHECK SYSTEM of the *Gibbs-Inman Co.*, of Louisville, Atlanta, is set out in a different way (fig. 256), in that the three lists of dollars, dimes and cents are stepped and reproduced symmetrically on the left and right-hand side of the ticket; each of them is doubled by an auxiliary list one unit lower.

All the tickets listed below, based different principles, are printed wit double list, in two adjacent colum showing all the fares charged or all places served, often followed by a list categories. One notch suffices for sho ing the fare but two are necessary for places, and a further one for the catego

A SYSTEM PATENTED ON THE 30TH JU 1891 (fig. 255) (3), and the DREW TICKET, both used in conjunction w special cutters (4), have a double list places and categories. The name of departure station is written in by ha

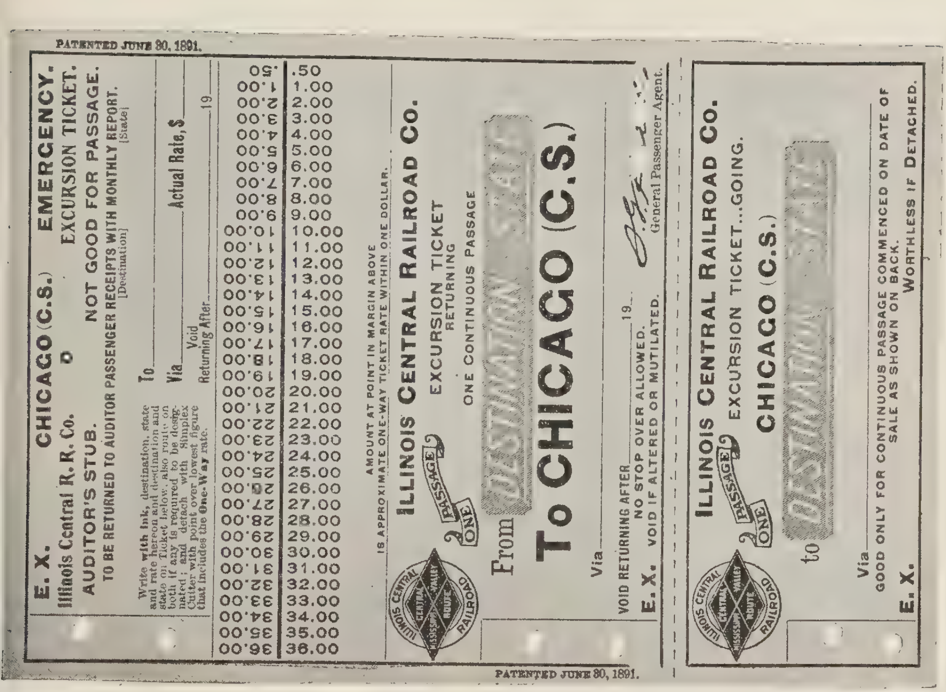
---

(1) *Birmingham and Atlantic R. R.; Tampa Southern R. R.*

(2) *K. C. C. C. and St. Louis Ry. Co.*

(3) On the *Illinois Central R. R. Co.*, the figures in the two adjacent lists are printe reversed relatively to each other.

(4) The ticket was patented on the 19th June, 1891, and the cutter on the 13th Augus 1907. Supplied by *Poole Bros.*, of Chicago, to the *New Mexico Central Ry. Co.* with sp cial categories : half rate or clergy. The number of the validation card is added.



PATENTED JUNE 30, 1891.

E. X. CHICAGO (C.S.) EMERGENCY.
Illinois Central R. R. Co. EXCURSION TICKET.
AUDITOR'S STUB. NOT GOOD FOR PASSAGE.
TO BE RETURNED TO AUDITOR PASSENGER RECEIPTS WITH MONTHLY REPORT.
[Destination] [State]

Write with Ink, destination, state and rate hereon and destination and state on Ticket below; also route on both if any is required to be designated; and detach with Simplex Cutter with point over lowest figure that includes the One-Way rate.

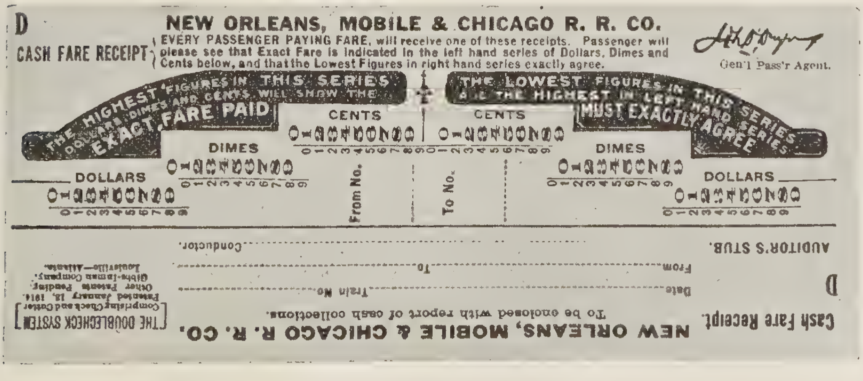
To ____
Via ____ Actual Rate, $ ____
Void Returning After ____ 19__

.50 1.00 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00 11.00 12.00 13.00 14.00 15.00 16.00 17.00 18.00 19.00 20.00 21.00 22.00 23.00 24.00 25.00 26.00 27.00 28.00 29.00 30.00 31.00 32.00 33.00 34.00 35.00 36.00

AMOUNT AT POINT IN MARGIN ABOVE
IS APPROXIMATE ONE-WAY TICKET RATE WITHIN ONE DOLLAR.

ILLINOIS CENTRAL RAILROAD CO.
EXCURSION TICKET
RETURNING
ONE CONTINUOUS PASSAGE
2 PASSAGE ONE
From DESTINATION STATE
To CHICAGO (C.S.)
Via
VOID RETURNING AFTER ____ 19__
NO STOP OVER ALLOWED.
E. X. VOID IF ALTERED OR MUTILATED.
General Passenger Agent.
PATENTED JUNE 30, 1891.

ILLINOIS CENTRAL RAILROAD CO.
EXCURSION TICKET...GOING.
CHICAGO (C.S.)
2 PASSAGE ONE
to DESTINATION STATE
Via
GOOD ONLY FOR CONTINUOUS PASSAGE COMMENCED ON DATE OF SALE AS SHOWN ON BACK.
E. X. WORTHLESS IF DETACHED.



D NEW ORLEANS, MOBILE & CHICAGO R. R. CO.
CASH FARE RECEIPT EVERY PASSENGER PAYING FARE, will receive one of these receipts. Passenger will please see that Exact Fare is indicated in the left hand series of Dollars, Dimes and Cents below, and that the Lowest Figures in right hand series exactly agree.
Gen'l Pass'r Agent.

THE HIGHEST FIGURES IN THIS SERIES DOLLARS, DIMES AND CENTS WILL SHOW THE EXACT FARE PAID

THE LOWEST FIGURES IN THIS SERIES AND THE HIGHEST IN LEFT HAND SERIES MUST EXACTLY AGREE

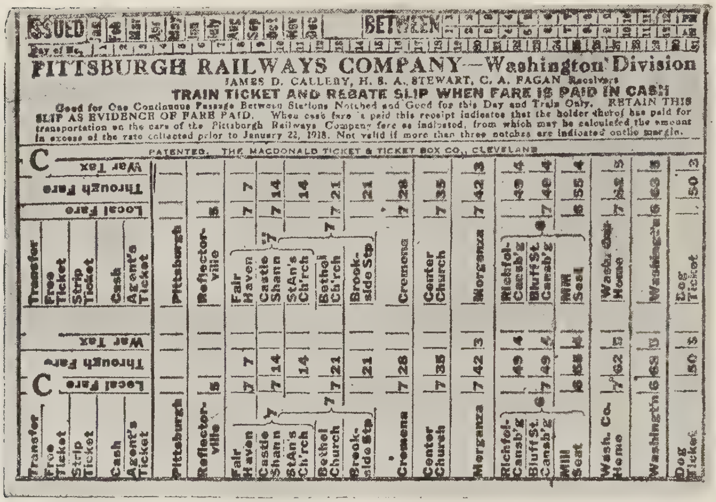
CENTS 0 1 2 3 4 5 6 7 8 9 | CENTS 0 1 2 3 4 5 6 7 8 9
DIMES 0 1 2 3 4 5 6 7 8 9 | DIMES 0 1 2 3 4 5 6 7 8 9
DOLLARS 0 1 2 3 4 5 6 7 8 9 | DOLLARS 0 1 2 3 4 5 6 7 8 9
From No. To No.

Cash Fare Receipt. NEW ORLEANS, MOBILE & CHICAGO R. R. CO.
To be enclosed with report of cash collections.
D Date ____ Train No ____
From ____ To ____
AUDITOR'S STUB. Conductor ____
[THE DOUBLECHECK SYSTEM Comprising Check and Cutter Patented January 13, 1914. Other Patents Pending. Gibbs-Inman Company, Louisville—Atlanta.]

Simplex tickets. (Red. 3/4).

g. 255. — *Illinois Central R. R. Co.* — Return ticket, patented in 1891 — With detachable outward coupon.

g. 256. — DOUBLE-CHECK SYSTEM single ticket of the *New Orleans, Mobile and Chicago R. R. Co.* — Part of the text in negative (white on black) printing.



ISSUED Jan. Feb. Mar. Apr. May June July Aug. Sep. Oct. Nov. Dec. BETWEEN 1 2 3 4 5 6 7 8 9 10 11 12 PM AM

Day of Mo. 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

PITTSBURGH RAILWAYS COMPANY—Washington Division

JAMES D. CALLERY, H. S. A. STEWART, C. A. FAGAN Receivers

TRAIN TICKET AND REBATE SLIP WHEN FARE IS PAID IN CASH

Good for One Continuous Passage Between Stations Notched and Good for this Day and Train Only. RETAIN THIS SLIP AS EVIDENCE OF FARE PAID. When cash fare is paid this receipt indicates that the holder thereof has paid for transportation on the cars of the Pittsburgh Railways Company fare as indicated, from which may be calculated the amount in excess of the rate collected prior to January 22, 1918. Not valid if more than three notches are indicated on the margin.

PATENTED. THE MACDONALD TICKET & TICKET BOX CO., CLEVELAND

C

Transfer | Free Ticket | Strip Ticket | Cash | Agent's Ticket

	Local Fare	Through Fare	War Tax
Pittsburgh			
Reflectorville	5		
Fair Haven	7	7	
Castle Shann	7	14	
StAn's Ch'rch		14	
Bethel Ch'rch	7	21	
Brookside Stp		21	
Cremona	7	28	
Center Church	7	35	
Morganza	7	42	3
Richfol-Canab'g		49	4
Bluff St. Canab'g	7	49	4
Mill Seat	6	55	4
Wash. Co. Home	7	62	5
Washington	6	63	5
Dog Ticket		50	3

Fig. 257. — *Macdonald* patent simplex ticket. (Red. 3/4) — *Pittsburgh Rys. Co.* — With categories and places — Local rates, through rates, and war tax — Lists of months, dates and hours.

A duplex coupon is added to both these tickets in the case of returns.

The POTTER PATENT TICKET (¹) is based on similar principles and also has a duplex coupon for the return trip.

The MACDONALD TICKET AND TICKET BOX Co., of Cleveland. — Some of their tickets have a double list of fares printed side by side, others, a list of stations, and others again, lists of stations with the fares against them. These lists generally follow lists of categories (²), but there are interesting variations of all these arrang ments.

The list of ordinary fares may be fol owed by lists of special fares for dog parcels or special rates (³). Instead lists of places, a list of zones with th end stations may be given for each lin Sometimes a reference list of statio with their numbers is added, so that on their numbers and not their names nee be given in the double list, which is be notched. Often the figures list is fol owed by a list of digits (⁴).

(¹) *Potter*'s patent ticket is used with the « Potter Patent Cutter ». On the *Illinois Traction System*, the list of destination stations on the supplementary duplex coupon is reversed relatively to the other lists, which are identical. The return coupon is always the middle one, the outward half is on the right, and the check coupon, on the left.

(²) On the *Milwaukee Electric Ry. and Light Co.*, the following are listed : fractional fare, minimum price, cash; city zone tickets; employee; half price, child; free pass for Company's officers.

(³) *Norfolk Southern R. R. Co.* Tariff of 10 cents per zone.

(⁴) *Washington, Baltimore and Annapolis Electric R. R. Co.*

The list of categories is completed by
at of the rates (1). Finally, if required,
e check indications for the journey,
ich as the days of the week, hours, etc.,
e given in the usual way. Refund
ckets always show them (2).

Another arrangement (fig. 257), in-
uding duplicated columns, adds the
mount of the fare divided into three
olumns stating local rates, transit rates
nd taxes beside each of the duplicated
sts of stations (3).

CHAPTER VI.

IMITED-PARAMETER TICKETS (Contd.)

B. — Parameter tickets without preprinted lists (blank tickets).

Instead of determining one element of a
arameter-preprinted list, blank tickets
ompletely omit one or several of the data.
he choice of an element for a journey
no longer restricted to one of a list of
ames, but may be selected from amongst
ll existing ones of the same kind, whe-
ier quoted or not. Blank or semi-blank
ckets do not mention, according to the
ind :

the stations (destination, starting place or
ute);
the category;
the class;
the number of passengers (party blank
kets);
or any of these factors.

These blank tickets are the Continental « blanco », the British « emergency » and the American « skeleton » tickets.

Whoever issues the ticket always keeps a record of it, and checking should be possible at any time. Accurate duplication of all supplementary information is indispensable.

These blanks thus replace entire series of tickets. And they form a reserve stock for any of the others. On the other hand, it takes longer to issue them, it is more difficult to check them, and it is harder to draw up statistics from them.

The supplementary indications are written by hand, both on the Edmondson tickets and on their stubs. Carbons render it easier to duplicate and triplicate blank paper tickets for checking or other purposes.

The manipulation of these tickets has been helped through the provision of rubber stamps and double-entry tables. The list of reasons for issuing them serve as headings for the horizontal lines, while the headings of the columns show the class and the amounts to be collected in fares (units and fractions) (4). Passengers may be given either the original ticket (5), or its duplicate (6).

The class may be shown in different ways. Booklets of various colours may be used, but this means running three lots of tickets, one for each class. Or the number of the class may be written in by hand. Or again, the blank ticket may have three grids whose colours correspond with those of the classes, one of the fac-

---

(1) *Fox and Illinois Union Ry. Co.*

(2) *Warren and Jamestown St. Ry. Co.*

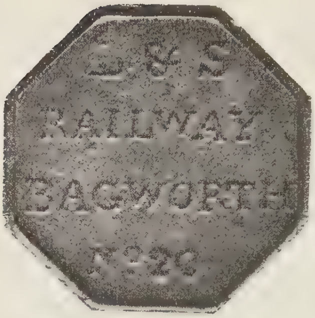
The rebate is 5 or 10 cents, depending on
ticket.

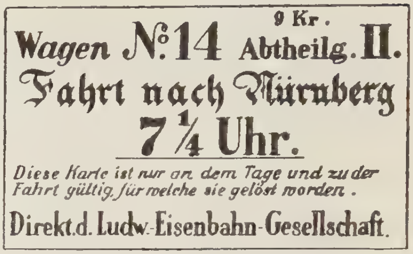
(3) *Pittsburgh Rys. Co.*

(4) *Italian State Rys.*

(5) *Belgian National Rys. Co.*

(6) *Netherlands Rys.*




9 Kr.

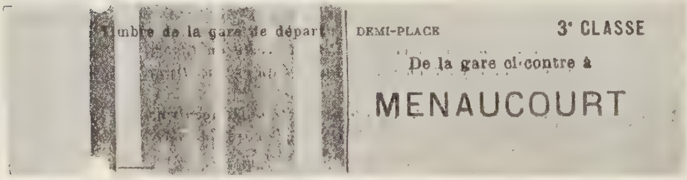
Wagen №14 Abtheilg. II.

Fahrt nach Nürnberg

7 ¼ Uhr.

Diese Karte ist nur an dem Tage und zu der Fahrt gültig, für welche sie gelöst worden.

Direkt. d. Ludw.-Eisenbahn-Gesellschaft.


Timbre de la gare de départ

DEMI-PLACE 3e CLASSE

De la gare ci-contre à

MENAUCOURT

Semi-blank tickets with name of destination station only. (Full size).

Fig. 258. — Octogonal metal ticket of the *Leicester and Swannington Ry.*, 1832 — With number of ticket — *London Science Museum* collection.

Fig. 259. — Earliest German cardboard ticket, 1835 (Full size) — *Ludwigs Eisenbahn Gesellschaft.*

Fig. 260. — To be stamped at departure station. (Red. 3/4) — Special red bands.

tors of the journey, the destination for instance, being written on one of the grids (fig. 279) (¹).

Special care must be taken to prevent the tickets being tampered with. A simple device consists in using double-sided carbons which duplicate the writing both on the duplicate and the back of the ticket itself. The back of the latter is sometimes carbon-treated, so that the writing is directly reproduced on the duplicate; this is quicker but more expensive *(fig. 26)* (²).

The same methods are used in the case of triplicates, one of which is retained as a counterfoil, and the two others give to the passenger, who keeps one and give the other to the collector (³).

Anti-fraud holders have been devise for preventing access to the duplicate It is only necessary, in this chapter, t mention their existence; we deal wit these tickets in Chapter VIII-D.

Issuing Edmondson blank tickets i slow, because the indications have to b written in twice by hand, on the ticke proper and on the stub. When the latte is too small, as on return tickets, large cards of 83 instead of 57 mm. (3 1/4 instead of 2 1/4") are used *(fig. 63)*. A

(¹) Standard type on all the Swiss railways.

(²) French main-line railways.

(³) *International Sleeping Car Co.*

ast two factors have always to be record-
, one of them being the fare. But owing
all this extra work and inconvenience,
ank Edmondson tickets are hardly used
cept as free passes.

Semi-blank tickets of all categories,
th no printed destination, are wide-
read. They followed, without transi-
n, the old stage-coach checks previously
sued in large cities, which the early
ilways servilely imitated *(figs. 4* and *5)*.
a necessary corollary, the fare was
so blank (figs. 52 and 150).

Most railways now have Edmondson
mi-blank tickets, generally with a con-
l stub on which the ticket's added data
e repeated in ink.

When each class has a uniform fare,
kets also coming under this heading
e used. On the Paris *Metropolitain Ry.*,
ch station whose name is printed on
e tickets, issues them to every other
tion on the system (fig. 268). Such
kets are in fact semi-blanks on which
e complementary missing indications
ed not appear.

The opposite method, with printed des-
ation and blank departure station,
ugh just as old, as it goes back to the
y beginning of railways, is used to any
ent only in America.

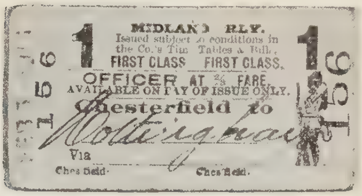
The London Science Museum kindly
t us a photograph of a brass ticket
ed on the *Leicester and Swannington*
. from the time it was opened (17th
y, 1832) till it was taken over by the
dland Ry. Co. (1846). In addition to
Company's initials, these tickets only
e the name of the destination station
d a serial number (fig. 258). The latter
s recorded in a register together with
fare paid. The guard collected these
tal tickets and put them in a box with
isions corresponding to each of the issuing stations. At the completion of the journey, the tickets were returned to the several issuing stations for use again.

The first German tickets, used in 1835 by the *Fürth-Nuremberg Ry. (Ludwigs Eisenbahn Gesellschaft)*, were similar inasmuch as they quoted the name of the arrival station and were serially numbered, but they bore other indications as well (fig. 259).

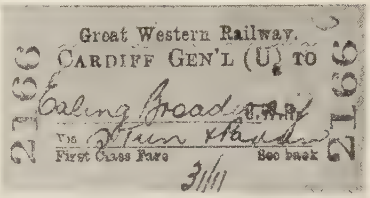
This system no longer exists in Europe, except on a few French local lines (fig. 260), but is still widely used in America. It enables the Companies to print one kind of ticket per category for each destination. The tickets are then distributed to all stations, even to those needing only a few of them annually. When issuing them, all that is required is to add the date and name of the issuing station and the amount of the fare; the latter is a serious drawback as it takes time and may lead to errors.

A new kind of ticket introduced in 1932 might be included in this group : we refer to those issued for mystery trains, whose destination is unknown to the passenger, and not stated on the ticket. The *Great Western Ry.* (England) was the first to issue them (fig. 262). Other main-line railway Companies were not slow to copy them (fig. 266), and certain light railway and even tramway Companies did likewise (fig. 267).

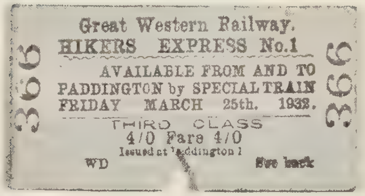
Fixed-fare blank tickets. — The issue has been simplified by using paper tickets on which only the fare is printed, and no mention made of the journey for which they are issued or of the object of the collection (fig. 272). The train staff are supplied with a very complete series of tickets of all the usual values; several tickets whose combined value makes up the amount to be collected are used for other fares.



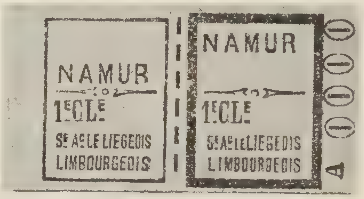
MIDLAND RLY.
Issued subject to conditions in the Co.'s Time Tables & Bills.
1 FIRST CLASS FIRST CLASS 1
OFFICER AT 2/3 FARE
AVAILABLE ON DAY OF ISSUE ONLY.
Chesterfield to
Nottingham
Via
Chesterfield Chesterfield
3156 3156



Great Western Railway.
CARDIFF GEN'L (U) TO
Ealing Broadway
Via [illegible]
First Class Fare See back
3/11
2166 2166



Great Western Railway.
HIKERS EXPRESS No.1
AVAILABLE FROM AND TO
PADDINGTON by SPECIAL TRAIN
FRIDAY MARCH 25th. 1932.
THIRD CLASS
4/0 Fare 4/0
Issued at Paddington
WD See back
366 366



NAMUR
1e CLe
Ste Ale LIEGEOIS LIMBOURGEOIS
NAMUR
1e CLe
Ste Ale LIEGEOIS LIMBOURGEOIS
A 0010

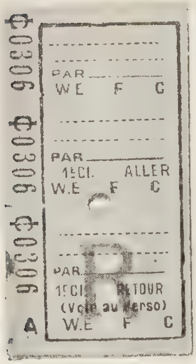
Tickets with blank destination. (Red. 4/5).

Fig. 261. — *Midland Ry.* — Category : Officer at 2/3rds fare — With military vignette — Class shown by large number.

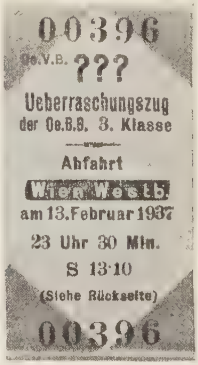
Fig. 262. — Ticket for a train whose destination is unknown to the passenger — First mystery train ever run — *Great Western Ry.*, 1932.

Fig. 263. — Single ticket with blank dest ation — *Great Western Ry.* — New safe background now in use.

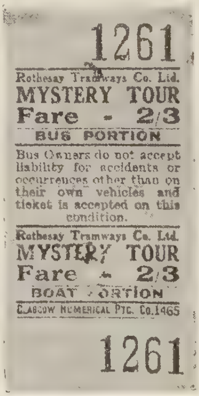
Fig. 264. — Old return ticket — *Belgi State Rys.* (1870) — Joint service with t former *Liégeois-Limbourgeois Ry. Co.*



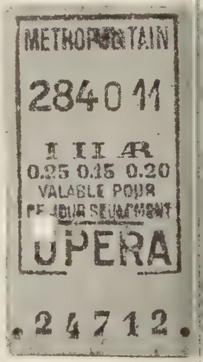
0306 0306 0306
PAR
W.E F C
PAR
1e Cl. ALLER
W.E F C
PAR
1e Cl. RETOUR
(Voir au verso)
A W.E F C



00396
Oe.V.B. ???
Ueberraschungszug
der Oe.B.B. 3. Klasse
Abfahrt
Wien Westb.
am 13. Februar 1937
23 Uhr 30 Min.
S 13·10
(Siehe Rückseite)
00396



1261
Rothesay Tramways Co. Ltd.
MYSTERY TOUR
Fare - 2/3
BUS PORTION
Bus Owners do not accept liability for accidents or occurrences other than on their own vehicles and ticket is accepted on this condition.
Rothesay Tramways Co. Ltd.
MYSTERY TOUR
Fare - 2/3
BOAT PORTION
GLASGOW NUMERICAL PTG. CO. 1465
1261



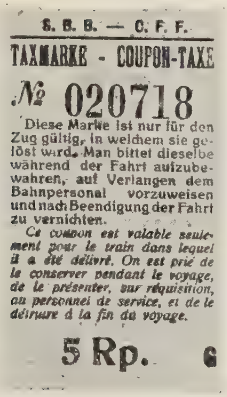
METROPOLITAIN
284011
I II AR
0.25 0.15 0.20
VALABLE POUR
LE JOUR SEULEMENT
OPERA
24712

Fig. 265. — Edmondson blank ticket with control coupon. (Red. 4/5) — Category week end — International Convention monogram — Lateral ticket number.

Fig. 266. — *Austrian Federal Rys.* — Mystery tour ticket. (Red. 4/5) — Corner colouring — Name of departure station in negative print.

Fig. 267. — *Rothesay Tramways Company* — Mystery tour ticket for bus and boat journey (Red. 4/5).

Fig. 268. — Paris *Metropolitain Ry.* ticket for any station. (Red. 4/5) — With name o issuing station — Printed when issued.



S. B. B. — C. F. F.

TAXMARKE - COUPON-TAXE

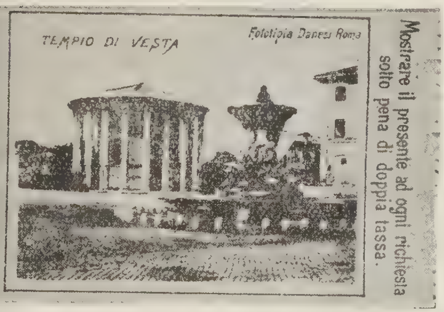
№ 020718

Diese Marke ist nur für den Zug gültig, in welchem sie gelöst wird. Man bittet dieselbe während der Fahrt aufzubewahren, auf Verlangen dem Bahnpersonal vorzuweisen und nach Beendigung der Fahrt zu vernichten.

Ce coupon est valable seulement pour le train dans lequel il a été délivré. On est prié de le conserver pendant le voyage, de le présenter, sur réquisition, au personnel de service, et de le détruire à la fin du voyage.

5 Rp. 6

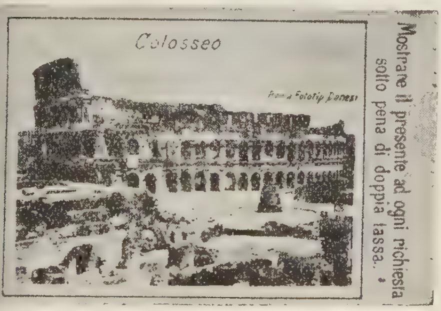
269. — Receipt issued in the train. (Red. /4) — *Swiss Federal Rys.* — The amount shown in « rappen », though the curren- used has long been centimes.



TEMPIO DI VESTA

Fototipia Danesi Roma

Mostrare il presente ad ogni richiesta sotto pena di doppia tassa.

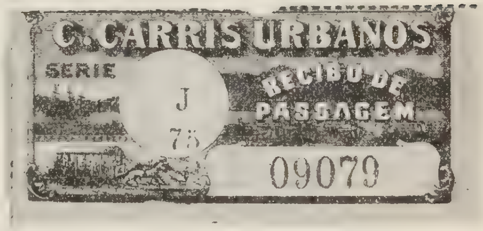


Colosseo

Fototip Danesi

Mostrare il presente ad ogni richiesta sotto pena di doppia tassa.

270 and 271. — Old fixed-price tickets ailable for any journey at the correspond- fare (full size) — *Societa Romana dei amways* (1875) — The photographs show nous ruins in the town.



C. CARRIS URBANOS

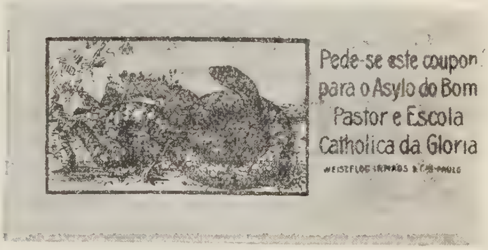
SERIE

J

75

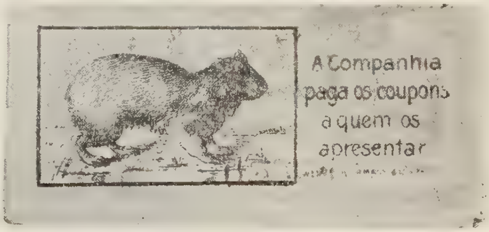
RECIBO DE PASSAGEM

09079



Pede-se este coupon para o Asylo do Bom Pastor e Escola Catholica da Gloria

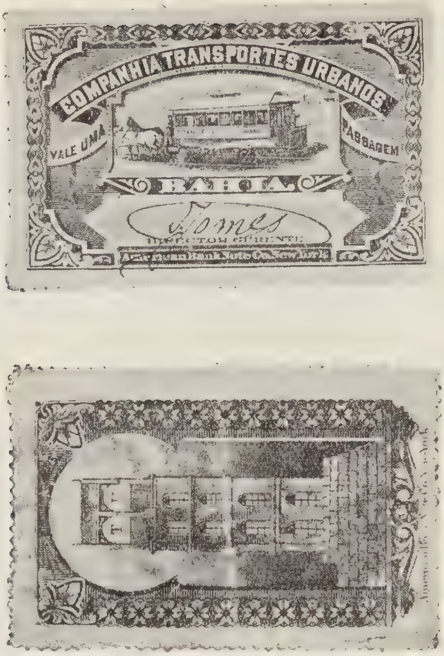
WEISZFLOG IRMÃOS & C.IA S. PAULO



A Companhia paga os coupons a quem os apresentar

Figs. 272 and 273. — Face and back of old Rio de Janeiro tickets (full size) — Receipt for a fare paid — Illustrated with pictures of animals.

For control purposes, the Company bought back used tickets for a small sum. When the tickets were given to the Asile du Bon Pasteur (Almshouse), or the Catholic Gloria School, these charities benefited by the rebate.


COMPANHIA TRANSPORTES URBANOS
VALE UMA
PASSAGEM
BAHIA
Gomes
DIRECTOR GERENTE
American Bank Note Co. New York

Figs. 274 and 275. — Face and back of tickets available for one journey, neither fare nor route being shown — *Bahia Urban Transport Company*, Brazil — (Full size) — Engraved by the *American Bank Note Company*, of New York, about 1878.

The earliest tramways originally issued tickets of this kind without any indication about the journey proper (figs. 270 to 275). This is still the practice in America, where books of travel-elements, and in France, where fare-elements, are sold in advance. We shall return to this subject in Chapter IX-B.

Emergency tickets. — On these tickets, all information about the journey is omitted, the class and category alone being printed. The names of the departure and destination stations, the route and the fare, are filled in by hand. Figure 265 shows an Edmondson week-end return ticket with control coupon. A historical example of the use of paper ticke of the kind occurred on the Belgian Ra ways after the Armistice, whilst th awaited delivery of the Edmonds tickets they had ordered. Blocks of di ferently coloured paper tickets of ea class, full and half-fare singles and r turns, were provided, and the name a date of the issuing station stamped with post-office material.

Blank tickets. — Going one st further, all indications as to class a category may be left out as well, and single ticket stocked to meet all requi ments. A separate colour of Edmondso cards (often white) (fig. 265), or of pa of paper tickets, is often apportion them. Figures 276 to 278 show the fa and back of Belgian tickets used for short time immediately after the Armi tice.

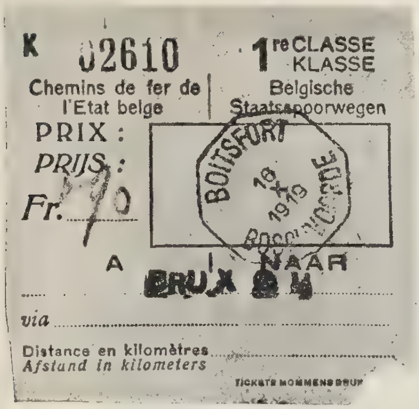
Save when there is sufficient deman only a single sort of blank ticket, issu either at the booking office or on t train, is used for one (figs. 241 and 24 or more passengers travelling togeth (figs. 243, 279 and 280).

By means of ingenious devices, certa Railways have made it possible to dete mine automatically some of these ticke too numerous variable factors, such the class, by detaching the ticket fro its stub at different points according the class (fig. 243), or the fare, by t use of the pre-slotted tickets (fig. 28 to which we referred above.

CHAPTER VII.

COUNTREMARKS AND EXCHANGE TICKETS.

This system consists in giving the pa senger a free ticket called a counterma



K 02610 1re CLASSE KLASSE

Chemins de fer de l'Etat belge | Belgische Staatsspoorwegen

PRIX : PRIJS : Fr. 70

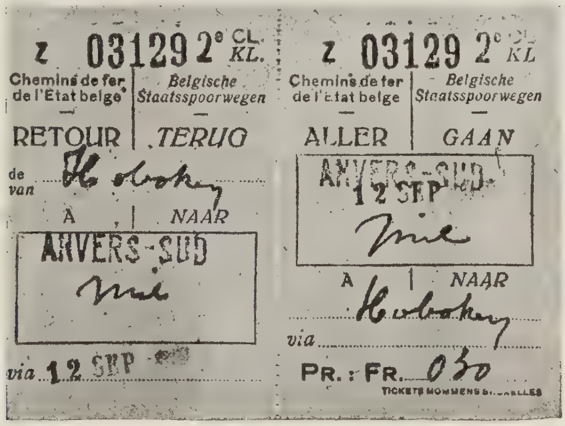
BOITSFORT 19 X 1919

A | NAAR BRUX [illegible]

via

Distance en kilomètres
Afstand in kilometers

TICKETS MOMMENS BRUX



Z 03129 2e CL. KL. | Z 03129 2e CL. KL.

Chemins de fer de l'État belge | Belgische Staatsspoorwegen | Chemins de fer de l'État belge | Belgische Staatsspoorwegen

RETOUR | TERUG | ALLER | GAAN

de van Hoboken

A | NAAR ANVERS-SUD

via 12 SEP

ANVERS-SUD 12 SEP

A | NAAR Hoboken

via

PR. : FR. 030

TICKETS MOMMENS BRUXELLES

igs. 276 to 278. — Temporary blank tickets used immediately after the Armistice by the *Belgian State Rys.* (Red. 3/4) — Single (face and back) and return tickets printed in two languages — Dated with Post Office stamper — Coat of arms on the back.

exchange ticket, which has no moneta-
value in itself, to prove that he held a
l or half-fare ticket which has been
lected.

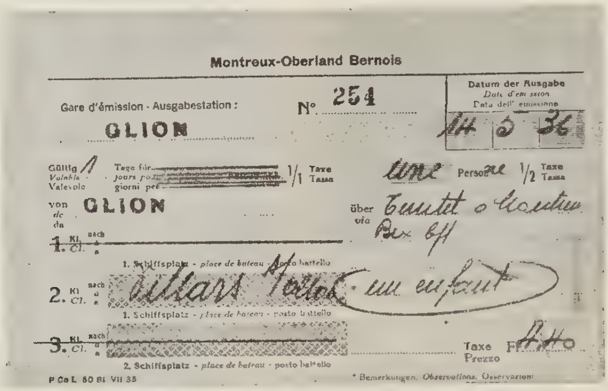
British road transport Companies use
m frequently (figs. 281 to 284). They
ner bear the same nominal value as the ticket they replace, or a list of values (parameter-list) for one of which they may be exchanged. Beyond a certain sum, such lists may be completed by grouped fares such as « from two shillings to two and sixpence » or « three shillings and above » (1). These amounts relate to the

---

(1) *Green's Motors Ltd.*, of Haverfordwest, South Wales.

full fare, but they are often followed, if necessary, by a list of the exchange fares for discount vouchers. Whatever method is used, the value corresponding to that of the original ticket is always perforated.

The countermarks of Continental road transport Companies are generally paper tickets issued in exchange for through tickets, or more rarely for returns.



Montreux-Oberland Bernois

Gare d'émission - Ausgabestation : GLION

N° 254

Datum der Ausgabe / Date d'émission / Data dell' emissione: 14 5 36

Gültig / Valable / Valevole 1 Tage für / jours pour / giorni per ~~[illegible]~~ 1/1 Taxe / Tassa

une Personne 1/2 Taxe / Tassa

von / de / da GLION

über / via [illegible] Bex [illegible]

~~1. Kl. / Cl.~~ nach / à / a

1. Schiffsplatz - place de bateau - posto battello

2. Kl. / Cl. nach / à / a Villars [illegible] un enfant

1. Schiffsplatz - place de bateau - posto battello

~~3. Kl. / Cl.~~ nach / à / a

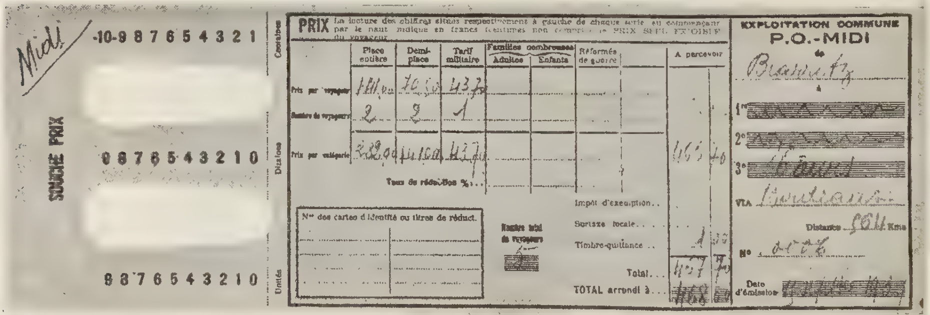
2. Schiffsplatz - place de bateau - posto battello

Taxe / Prezzo Fr. 4.40

P Co L 80 Bl VII 35

* Bemerkungen. Observations. Osservazioni

Fig. 279. — Standard blank ticket used on all Swiss Railways. (Red. 3/4) — *Montreux Oberland Bernese Rys.* — Safety background grid of different colour for each class.



Midi

SOUCHE PRIX

-10-9 8 7 6 5 4 3 2 1 Centaines

9 8 7 6 5 4 3 2 1 0 Dizaines

9 8 7 6 5 4 3 2 1 0 Unités

PRIX La lecture des chiffres situés respectivement à gauche de chaque série en commençant par le haut indique en francs (centimes non compris) le PRIX SEUL EXIGIBLE du voyageur.

	Place entière	Demi-place	Tarif militaire	Familles nombreuses Adultes	Familles nombreuses Enfants	Réformés de guerre		A percevoir
Prix par voyageur	141.00	70.50	43.70					
Nombre de voyageurs	2	2	1					
Prix par catégorie	282.00	141.00	43.70					466.70
Taux de réduction %								
Impôt d'exemption..								
Surtaxe locale..								
Timbre-quittance ..								1.00
Total...								467.70
TOTAL arrondi à...								468

Nos des cartes d'identité ou titres de réduct.

Nombre total de voyageurs 5

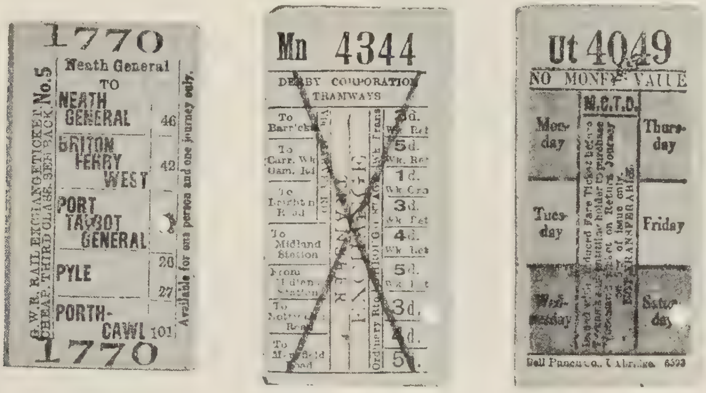
EXPLOITATION COMMUNE
P.O.-MIDI
de Biarritz
à
1re
2e
3e [illegible]
VIA [illegible]
Distance 611 Kms
N° [illegible]
Date d'émission [illegible]

Fig. 280. — *P.O.-Midi Rys.*, France — Blank ticket — Double-entry table showing numbe of passengers or categories — Three safety grids for the classes — Number of the legitin ation card — Oval cut-out slits show the fare charged — Safety background obtaine by repetition of Company's name. (Red. 1/2).

Railway Companies also use them fr quently, and though the primary object to facilitate control, they serve widely di fering purposes as well. For the sake convenience, the railway countermark nearly always an Edmondson ticket, sa in America, where the type varies acco ing to its use.

Control countermarks determine t route actually followed by the passeng r check his use of the Company's serices.

In the first case, the countermark is iven in exchange for a ticket coupon coering the section of the journey where ie passenger may travel by one of several outes.



Road transport Companies countermarks or exchange tickets. (Red. 4/5).

Fig. 281. — Issued on one of the *Great Western Ry.*'s motor services in exchange for a railway ticket — Multiple destinations with the corresponding number of stage points.

Fig. 282. — Interchange countermark — *Derby Corporation Tramways* — List of possible destinations — Corresponding fares per category, one of which bust be clipped.

Fig. 283. — Workman's countermark showing the day of the week by perforation — *Manchester Corporation Transport Department* — Printed in three colours : red, yellow and green.

This occurs when alternative lines are vned by different Companies, or were ie section of the journey can be made ther by rail, boat or road motor. Return ckets frequently allow a choice of route r the return journey, and exchanging coupon for a countermark makes adjustent between the different companies sy.

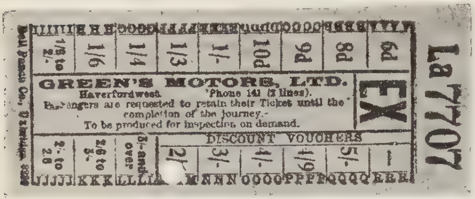
A second kind is very generally used in nerica. The ticket is collected and in its ace, a check giving the number of the it occupied is delivered (figs. 285 and 6). The passenger has to display it conspicuously, for example in his hat band or on top of his seat, until it is collected towards the end of the journey.

Exit countermarks have long been in use when tickets are collected on the train or the boat before arrival at destination.

We have already mentioned the elliptical countermarks used by the former *Liége-Maestricht Railway (fig. 142).* Figure 291 shows an Uruguayan check overprinted with two successive seals, the second of which renewed its validity after it had been used once.

Though exit countermarks are now seldom used by railways, they are still popular on board ship under the name of « landing tickets ». The ticket proper, which includes the passage fare, harbour dues and disembarkation fees, is retained by the boat staff, while the Harbour

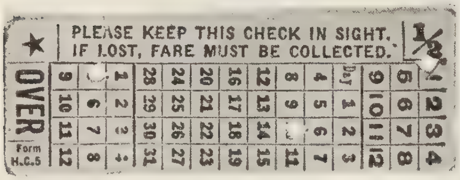
Authorities keep the landing ticket. The settlement between the two entities is an easy one, each having an actual voucher.



GREEN'S MOTORS, LTD.
Haverfordwest. 'Phone 141 (3 lines).
Passengers are requested to retain their Ticket until the completion of the journey.
To be produced for inspection on demand.
DISCOUNT VOUCHERS

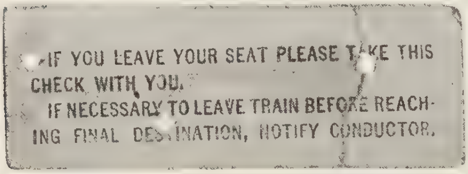
6d
8d
9d
10d
1/-
1/3
1/4
1/6
1/8 to 2/-
2/- to 2/6
2/6 to 3/-
3/- and over
2/-
3/-
4/-
4/9
5/-
EX
La7707

Fig. 284. — *Green's Motors Ltd.* elongated countermark showing the exchange values, one of which must be clipped (Red. 4/5).



PLEASE KEEP THIS CHECK IN SIGHT.
IF LOST, FARE MUST BE COLLECTED.

½
OVER
Form H.C.5
Day



IF YOU LEAVE YOUR SEAT PLEASE TAKE THIS CHECK WITH YOU.
IF NECESSARY TO LEAVE TRAIN BEFORE REACHING FINAL DESTINATION, NOTIFY CONDUCTOR.

Figs. 285 and 286. — American railways control countermarks, issued in exchange for railway tickets — List of months and dates — Recommendations to passenger.

The HUDSON AND MANHATTAN R. R. Co., of New York, uses a special system of exit coupons. Owing to its having two different fares on its system, 5 and 7 cents, and not checking the tickets in the cars, it has had to evolve a curious mode of control, which actually prevents fraud as well. This Company operates two lines :

(*a*) The first of them, in New-Jersey, runs through a downtown tunnel to the Huds Terminal Buildings.

(*b*) The second connects New-Jerse through an uptown tunnel with Manhatta up to the 33rd Street.

Tickets are purchased and deposited i boxes, at the point of entrance, and sp cial coupons at the point of exit.

The (*a*) downtown line having but single 5-cent fare does not require an coupons. So they are simply deposite in the boxes when entering the station and exit is free.

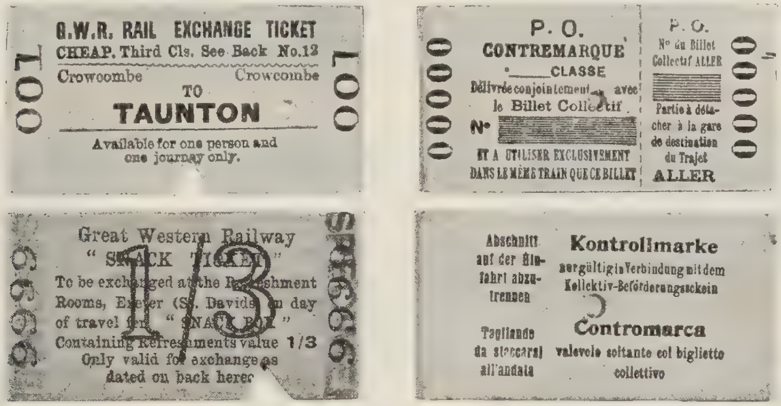
Not so on the (*b*) uptown line, th principle being that a 5-cent portion (o whole) of the ticket is deposited at th entrance-box in the usual way, and ap propriate coupons at the exit.

Through passengers pay 7 cents; the deposit their 5-cent ticket when enterin and a 2-cent complementary ticket whe leaving. Passengers using only the Ma hattan portion (without the tunnel fro New Jersey) pay but 5 cents, yet have deposit a ticket when leaving, otherwis all control would be impossible. Th means of accomplishing this is differe either way. When going eastward (tow ards 33rd St.), they enter by a speci turnstile, where they are given a speci no-value ticket which they deposit o leaving. When travelling westwa towards the tunnel, they deposit both 5-cent and a 2-cent fare ticket and a given, instead of the latter, a rebate co pon which the exit agent cashes.

Mileage-ticket countermarks are iss ed when a number of mileage or fa coupons corresponding to the mileage tr velled are collected from the passeng (fig. 296).

Collective or Party-tickets counte

arks make it possible for all the mem-
ers of a group to enjoy the privileges
ey are granted collectively through the
ngle ticket issued to them (figs. 289,
)0 and 293). This gives them more in-
vidual liberty than if they always had to
avel together as a group.



G.W.R. RAIL EXCHANGE TICKET
CHEAP. Third Cls. See Back No.12
007 Crowcombe Crowcombe 007
TO
TAUNTON
Available for one person and
one journey only.

Great Western Railway
" S[illegible]ACK T[illegible] "
6969 To be exch[illegible]ged at the R[illegible]shment 6969
Rooms, E[illegible]er (S[illegible]. Davids [illegible] day
of travel [illegible] " [illegible] "
Containing Refreshments value 1/3
Only valid for exchange as
dated on back hereo
1/3

00000 P. O.
CONTREMARQUE
•______CLASSE
Délivrée conjointement avec
le Billet Collectif
N°
ET A UTILISER EXCLUSIVEMENT
DANS LE MÊME TRAIN QUE CE BILLET

P. O.
N° du Billet
Collectif ALLER
Partie à déta-
cher à la gare
de destination
du Trajet
ALLER 00000

Abschnitt
auf der Ein-
fahrt abzu-
trennen

Kontrollmarke
nurgültig in Verbindung mit dem
Kollektiv-Beförderungsschein

Tagliando
da staccarsi
all'andata

Contromarca
valevole soltanto col biglietto
collettivo

Edmondson exchange tickets and countermarks. (Red. 4/5).

:. 287. — Rail countermarks exchanged for
road ticket on the *Great Western Ry.*

·. 288. — « Snack ticket » to be exchanged
or refreshments — *Great Western Ry.*

Figs. 289 and 290. — Face and back of return countermarks with smaller outward portion for passengers travelling on a party ticket — *Paris-Orléans Ry.* — The back is printed in German and Italian.

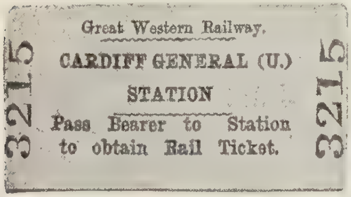
In addition to the usual method of issu-
; Edmondson tickets to every member
the group, mention may be made of a
y interesting system introduced by the
ıtral Argentine Ry. Their party tickets
e 16 countermark coupons, which can
detached and issued to each individual
nber of the group. If there are less
n 16, the booking clerk keeps the ad-
onal coupons; should there be more,
issues a second party-ticket.

'oot passenger countermarks. — To
ble passengers to enter or to pass
ugh certain parts of the stations, they

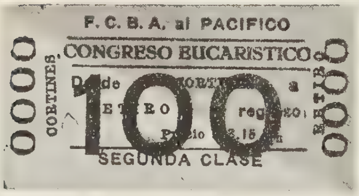
are given a special countermark in exchange for their tickets. This is done for instance, so as to enable them to obtain a ticket at the booking office. Figures 292 and 294 show old British and French countermarks of the kind.

Exchange tickets (fig. 375). — Certain tickets include a coupon of no travel value, which has to be exchanged for the proper ticket; this is almost the opposite to the countermark system, in which the passenger receives a ticket without any real value in exchange for a valuable one.

When a passenger retains the return portion of a ticket, it is apt to lead to fraud, as the distinctive marks which identify it with a given date and journey may be altered by unlawful holders. It is therefore to the Companies' advantage to withdraw it from circulation, and many of them, and particularly Road Transport Companies, collect them and hand the passenger, in their stead, exchange tickets of no face value, but available at the time of delivery only.



Great Western Railway.
CARDIFF GENERAL (U.)
STATION
Pass Bearer to Station to obtain Rail Ticket.
3215 3215



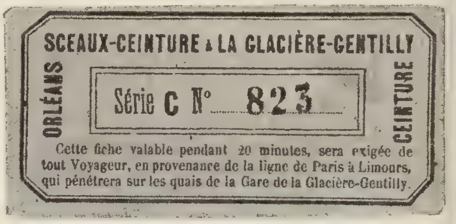
F. C. B. A. al PACIFICO
CONGRESO EUCARISTICO
Desde CORTINES a RETIRO regreso
Precio $ 2.15
SEGUNDA CLASE
0000 CORTINES RETIRO 0000
100

Edmondson countermarks. (Red. 4/5).

Fig. 291. — Exit countermarks — *Central Uruguay Ry.* — Old type — Stamped twice for reuse.

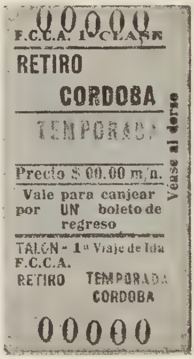
Fig. 292. — Token enabling passengers to go to the booking office — *Great Western Ry.*

Fig. 293. — Countermark for individual members of groups of 100 passengers — *Buenos Ayres and Pacific Ry.* — Eucharistic Congress — Bicolour ticket — Overprinted number of members of the group.

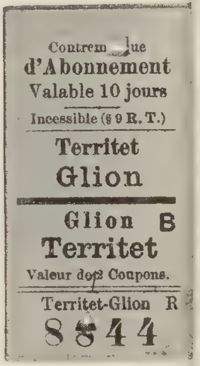


SCEAUX-CEINTURE à LA GLACIÈRE-GENTILLY
ORLÉANS Série C N° 823 CEINTURE
Cette fiche valable pendant 20 minutes, sera exigée de tout Voyageur, en provenance de la ligne de Paris à Limours, qui pénétrera sur les quais de la Gare de la Glacière-Gentilly.

Fig. 294. — Old entrance countermarks f passengers from another line admitti them to a station on the *Ceinture R* Paris. (Red. 4/5).



00000
F.C.C.A. 1a CLASE
RETIRO
CORDOBA
TEMPORADA
Precio $ 00.00 m/n.
Vale para canjear por UN boleto de regreso
Véase al dorso
TALON - 1a Viaje de Ida
F.C.C.A.
RETIRO TEMPORADA
CORDOBA
00000



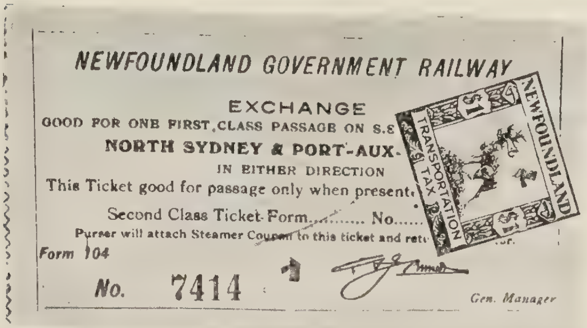
Contremarque
d'Abonnement
Valable 10 jours
Incessible (§ 9 R. T.)
Territet
Glion
Glion B
Territet
Valeur de 2 Coupons.
Territet-Glion R
8844

Edmondson countermarks. (Red. 4/5).

Fig. 295. — *Argentine Central Ry.* retu ticket with a countermark coupon to exchanged for the return ticket.

Fig. 296. — Season ticket countermark (iss ed in exchange for two coupons) — *T ritet-Glion Ry.* (Switzerland).

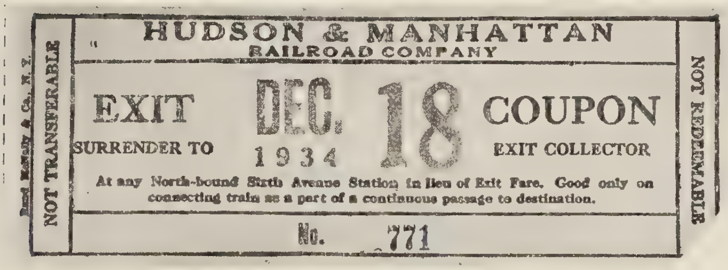
The railways have overcome this same drawback in various ways : in France, for example, by the costly method of using an indelible ink stamp; in the United States, by requiring the passenger to prove that he is the original holder o the outward ticket and validating the r turn ticket by witnesses; in the Argentine — the method we had particularly mind — by issuing special return ticke consisting of an ordinary outward ha and a second half which is, in fact, countermark. This is to be handed in



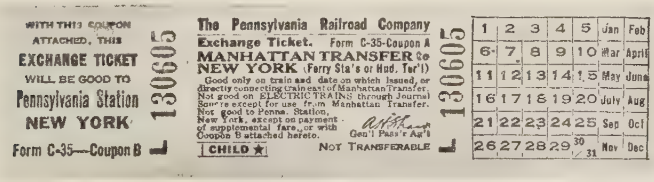
NEWFOUNDLAND GOVERNMENT RAILWAY

EXCHANGE
GOOD FOR ONE FIRST CLASS PASSAGE ON S.S
NORTH SYDNEY & PORT-AUX-
IN EITHER DIRECTION
This Ticket good for passage only when present
Second Class Ticket Form.......... No......
Purser will attach Steamer Coupon to this ticket and ret
Form 104
No. 7414
Gen. Manager

NEWFOUNDLAND
TRANSPORTATION TAX
$1
$1



HUDSON & MANHATTAN
RAILROAD COMPANY
EXIT
SURRENDER TO
DEC. 18
1934
COUPON
EXIT COLLECTOR
At any North-bound Sixth Avenue Station in lieu of Exit Fare. Good only on connecting train as a part of a continuous passage to destination.
No. 771
NOT TRANSFERABLE
NOT REDEEMABLE
Rand McNally & Co., N.Y.



WITH THIS COUPON
ATTACHED, THIS
EXCHANGE TICKET
WILL BE GOOD TO
Pennsylvania Station
NEW YORK
Form C-35—Coupon B
L 130605

The Pennsylvania Railroad Company
Exchange Ticket. Form C-35-Coupon A
MANHATTAN TRANSFER to
NEW YORK (Ferry Sta's or Hud. Ter'l)
Good only on train and date on which issued, or directly connecting train east of Manhattan Transfer. Not good on ELECTRIC TRAINS through Journal Square except for use from Manhattan Transfer. Not good to Penna. Station, New York, except on payment of supplemental fare, or with Coupon B attached hereto.
Gen'l Pass'r Ag't
CHILD ★
NOT TRANSFERABLE
L 130605

1	2	3	4	5	Jan	Feb
6	7	8	9	10	Mar	April
11	12	13	14	15	May	June
16	17	18	19	20	July	Aug
21	22	23	24	25	Sep	Oct
26	27	28	29	30 31	Nov	Dec

Exchange tickets. (Red. 3/4).

ig. 297. — To be exchanged, on showing the railway ticket, for a passage ticket — *Newfounland Government Ry.* — Transport tax stamp affixed.

g. 298. — Exit exchange ticket — *Hudson and Manhattan R. R. Co.* (New York) — Date printed.

g. 299. — New York exchange ticket. (Full size) — *Pennsylvania R. R. Co.* — Control coupon for the Manhattan-New York section — With table on which the date is shown by perforation (month and day) — Six-figure ticket number.

booking office before starting on the
ırn journey, and exchanged for a
et which can be used only on that
and for that particular journey
. 295).

A further category of exchange tickets also exists in America. Though the fare for the whole journey is paid at once, it may happen that one Company does not actually issue tickets for all the stations on another Companies' lines. In this case, the original ticket is exchanged without additional payment, at the station at which its availability expires, for another ticket to enable the journey to be completed (fig. 297).

On the *Great Northern Ry.* (U. S. A.), where paper « band » tickets are used, the return portion, issued at the same time as the complementary outward coupons, is available right back to the or ginal departure station, in spite of i being on the first line.

This exchange system also covers aux liary railway services. Thus, when pu chasing a ticket, it is possible, on som railways, to buy snack-tickets which ca be exchanged at other stations for a me (fig. 288).

(To be continued.)

[621. 131. 2 & 621. 133.3]

The firebox proportions of modern locomotive boilers.

discussion of modern tendencies in boiler development, leading up to certain conclusions concerning combustion chambers and other recent devices,

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(The Railway Gazette.)

The design of modern locomotive boirs has engaged much attention with e idea of improving performance. oiler proportions assume added imortance in view of the high sustained ower necessary to meet modern conditons, but it is clear that enlarged caacity is becoming difficult to attain by mere increase in dimensions. The most ursory glance at a modern locomotive sufficient to demonstrate the strength this statement.

Locomotive performance has been the ıbject of many experiments and investiıtions concerning the working of the oiler as a whole, and the action of its ımponent parts have also received uch attention. Tests on the road, and ı locomotive testing plants, have furshed much valuable information; an ample of the latter is the considerable ork carried out by the Pennsylvania ailroad on the locomotive testing plant Altoona, Pa., which is well known d appreciated as having furnished reble and valuable data. These trials and hers carried out in the United States ve established the fact, among others, at of the heat liberated by the firebox consistently high percentage is transrred across the heating surface; and rther, that boilers differing fairly wily in design show this to range beeen values of about 90 to 80 %. Furr, for a given boiler, the proportion the heat made available by the firex which is transferred across the heatg surfaces, remains the same within narrow limits, regardless of the rate of firing (measured by coal fired per square foot of grate area per hour).

From the foregoing it is generally concluded that the falling off in the overall or evaporative efficiency with each increment in the firing rate is not due to failure on the part of the heating surfaces to absorb the heat offered, but rather to losses in the efficiency of the combustion process; or, in other words, boiler efficiency is governed almost entirely by the heat-producing capabilities of the furnace. It is not surprising therefore that firebox design continues to receive much attention, and that the firebox proportions adopted by different designers differ in many respects.

The object of the present article is to consider the firebox proportions of modern boilers — that is, in respect to size, as expressed by cubic capacity, or volume, and also by the heating surfaces provided in relation to the area of the fire grate; and also to discuss the probable effect of changes made in the proportioning of the related dimensions. Further, as the grate area is necessarily the basis upon which any discussion on boiler proportions must rest, the size and the proportioning of the grate must first receive consideration.

The size of grate required will depend primarilly upon the power required, and the characteristics of the fuel to be used. Considerations of general design also govern to a varying extent the grate area finally adopted, firebox dimensions being ultimately determined by weight considerations, and by the desired wheel arrangement. Actually, the grate area is of prime importance, and in a general way it may be said that it can scarcely be made too large. The writer suggests that the correct method of evaluating the grate area required is to use the heating value of the coal expressed in B.Th.U. per lb. as a basis, and to assume a value for the power obtainable from each square foot of grate surface per hour. The power obtainable may be expected to increase with an increase in the value of the fuel fired, and in like manner it will become less when a fuel of lower calorific value is employed; from which it can be said that for an assumed power output, or for a given rate of firing, the area of the grate will be inversely proportional to the heat content of the fuel available. The method therefore of computing the grate area required would be as follows : in the first place the cylinder horsepower obtainable for each square foot of grate surface should be determined, and taking as a basis coal of good average quality, having a heat value of 14 000 B.Th.U., it is suggested that each square foot of grate surface will produce 40 I.H.P. under normal operating conditions.

Test results appear to show that approximately this power may be realised over a considerable range of working in the case of modern locomotives using superheated steam. Actually, the combination of speeds and the cut-offs used will depend upon the grate area in relation to the indicated tractive force, and to illustrate the effect of this, the writer has prepared a set of curves, figure 1, based on the following formula :

$$\frac{\dfrac{375}{V} \times 40}{\dfrac{\text{In. T.F.}}{\text{G.A.}}}$$

From the above, the percentage of th maximum In. T.F. (indicated tractiv force) can be obtained for any valu of the In. T.F./G.A. (grate area) fact and given speed in miles per hour. Ever curve represents a constant horsepow per square foot of grate area, and th set corresponds to five values for th In. T.F./G.A. factor, ranging from 600 1 000, and shows the proportion expres ed as a percentage of the cylinder tra tive effort available at speeds up 80 m.p.h. Thus, if the grate area is suc that the In. T.F./G.A. factor is 1 000, the at 60 m.p.h. the tractive effort availab at the cylinders is 25 % of the maximu and further, if the grate is enlarged as to make this factor 600, then as muc as 40 % of the cylinder tractive effo may be developed. This is interestin for there is now a notable tendency tow ards an increase in the grate areas pro vided.

It may be remarked that the ter indicated tractive force is used becau the horsepower assumed per square foo of grate area is the cylinder or indicate power. Approximately, the rated tra tive force which is measured at th rim of the driving wheels is 8 % le than the cylinder tractive force, whic being proportional to the mean effectiv pressure has a maximum value depen ing upon the cut-off in full gear.

Determination of grate area.

The grate area required is determin in the following manner : Assuming th 40 I.H.P. may be developed for ever square foot of grate when the fuel use has a heat value of 14 000 B.Th.U., the with coal of, say, the lower heat valu of 12 000 B.Th.U. and for the same pow output, the grate area would be :

$$\frac{40 \times 14\,000}{40 \times 12\,000} = 1.167$$

Thus, 1.167 sq. ft. would be necessary develop 40 I.H.P. In other words, pra tically 17 % more grate area would be required for the same indicated horsepower. Similarly, if the fuel to be used has a higher heat content of, say, 15 000 B.Th.U., then a smaller grate would meet requirements, thus :

$$\frac{40 \times 14\,000}{40 \times 15\,000} = 0.933$$

meaning that 40 I.H.P. would then be furnished by each 0.933 sq. ft. of grate area. If coal having a heat value of 15 000 B.Th.U. is used, then for 34 sq. ft. of grate the power obtained is $\frac{34}{0.93} \times 40 = 1\,460$ I.H.P., and to obtain the same power with 14 000 B.Th.U. fuel the grate area becomes :

$$\frac{1\,460}{40} = 36.5 \text{ sq. ft.}$$

From the foregoing, the expression for determining the grate area for a given indicated power, and using as a basis 40 I.H.P. per sq. ft. of grate with 14 000 B.Th.U. coal, would be :

$$\text{G.A.} = \frac{\text{H.P} \times 14\,000}{40 \times \text{F}}$$

where G.A. is the required grate area, H.P. the required I.H.P., and F is the heat value of the coal to be used.

Referring again to the curves in figure 1, it can be seen that the given I.H.P. at, say, some given speed in miles per hour, will correspond to a certain indicated tractive force, which can be determined as follows :

$$\text{In. T.F.} = \frac{\text{I.H.P.} \times 375}{\text{V}}$$

I.H.P. being the required power, and V the speed in miles per hour; further, the maximum cylinder tractive force being known, the relation between this and the grate area will enable, by means of the curves, the tractive effort avail-

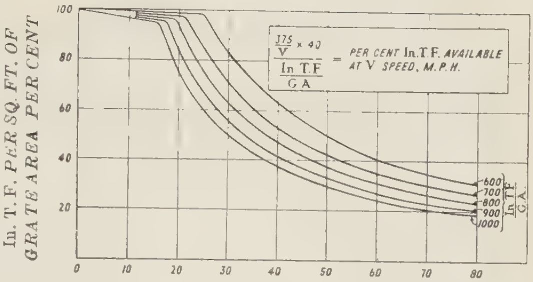

Fig. 1. — Graphs showing indicated tractive force per sq. ft. of grate against speed.

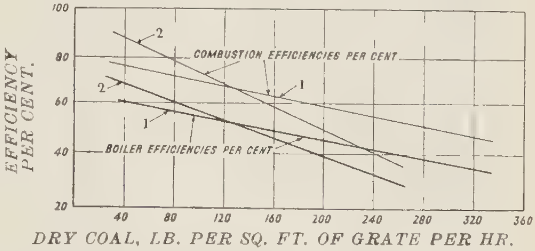

Fig. 2. — Graphs showing boiler and combustion efficiencies against firing rate.

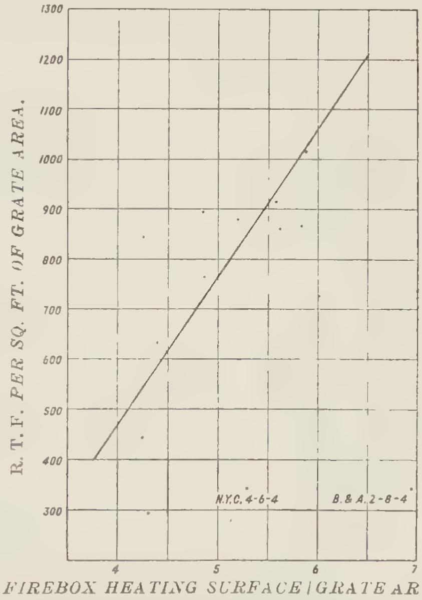

Fig. 3. — Graph showing firebox heating surface/grate area ratio, against tractive effort/grate area ratio.

TABLE I. — LOCO

RAILWAY.	1 *L.M.S.R.*	2 *L.N.E.R.*	3 *L.N.E.R.*	4 *German State*	5 *Nord*	6 *I. R. S.*	*A*
Locomotive type	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	4-6-2	
Rated tractive force (R.T.F)	40 300	36 465	35 455	41 700	32 000 *	26 750	44
Firebox type	Belp.	Round top	Round top	Belp.	Belp.	Round top	
Combustion chamber	Yes	Yes	Yes	No	No	Yes	
Syphons	No	No	No	No	No	No	
Arch tubes	No	No	No	No	No	Yes	
Heating surface, sq. ft., total (F.B.H.S)	217	215	231.2	183	219	214	
Volume, cu. ft. (F.B.V.)	261	252	274	248	226	255	
Grate area, sq. ft. (G.A.)	45.0	41.25	41.25	48 2	37.6	45.0	
Ratios :							
F.B.H.S./F.B.V.	0.83	0.853	0.843	0.738	0.97	0.84	
F.B.H.S./G.A.	4.82	5.21	5.63	3.78	5.83	4.76	
F.B.V./G.A.	5.8	6.1	6.64	5.12	6.0	5.66	
R.T.F./G.A.	896	880	860	862	852	596	

* Compound ; De Glenn

TABLE II. — LOCOMOTIVE BOILER FIREBOX PROPORTIONS.

RAILWAY.	1 *P.RR.*	2 *P RR.*	3 *S.A.R. & H.*	4 *S.A.R. & H.*	5 *B.-N.R.*	6 *S.A.R. & H.*	*L.*
Locomotive type	4-8-2	2-10-0	Garratt	Mallet	Garratt	Garratt	6
Rated tractive force (R.T.F.)	64 550	90 024 **	53 700	48 370	69 660	78 650 †	72
Firebox type	Belp.	Belp.	Belp.	Round top	Belp.	Round top	R
Combustion chamber	Yes	Yes	No	Yes	No	No	
Syphons	No	No	No	No	No	Yes	
Arch tubes	Yes	Yes	No	Yes	Yes	Yes	
Heating surface, total sq. ft. (F.B.H.S.)	399	287	211.3	250	286	340	
Volume, cu. ft. (F.B.V.)	582	364	311	327	...	...	
Grate area, sq. ft. (G.A.)	69.9	69.9	51.83	55.17	70	74.5	
Ratios :							
F.B.H.S./F.B.V.	0.684	0.787	0.677	0.763	...	...	
F.B.H.S./G.A.	5.71	4.11	4.07	4.52	4.09	4.55	
F.B.V./G.A.	8.33	5.21	6.0	5.92	...	...	
R.T.F./G.A.	923	1 286	1 034	874	995	1 054	1
F.B.H.S./F.B.V. *	0.635	0.709	...	...	...	...	

* Based on F.B.H.S. less heating surface of arch tubes.

† At 0.75 boiler pressure.

** 50 per cent. limited cut-off.

FIREBOX PROPORTIONS.

	9	10	11	12	13	14	15	16	17	18
C.	*B. & A.*	*L.M.R.S.*	*L.M.S. R.*	*L.M.S.R.*	*S. R.*	*G. W. R.*	*I. S. R.*	*I. S. R.*	*S. A. R. & H.*	*S. Aust. Govt. Rys.*
	2-8-4	4-6-0	4-6-0	4-6-0	4-6-0	4-6-0	4-6-0	2-8-0	4-8-2	2-8-4
	69 400 †	33 150	26 610	25 455	33 500	40 300	22 600	34 300	47 980	43 400
op	Belp.	Belp.	Belp.	Belp.	Belp.	Belp.	Belp.	Belp.	Round top	Round top
	No	...**	...**	No	...**	No	No	No	No	Yes
	No	No	No	No	No	No	No	No	No	Yes
	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes
	341	195	181	155	194	193.5	152.0	189.4	235.5	360
	465	210	203	166	...	...	...	...	...	...
	100.0	31.25	31.0	27.8	33.0	34.0	32.0	32.0	62.5	59.5
57	0.733	0.928	0.892	0.932	...	...	...	...	...	...
4	3.41	6.24	5.84	5 58	5.88	5.62	4.75	5.92	3.76	6.05
6	4.65	6.72	6.54	5.98	...	...	...	...	...	...
	694	1 060	858	915	1 015	1 185	706	1 063	768	728

cent. limited cut-off. ** Modified combustion chamber.

TABLE III. — LOCOMOTIVE BOILER FIREBOX PROPORTIONS.

RAILWAY.	1	2	3	4	5	6	7
	N. & W.	*U. P.*	*A.T.S.F.*	*N. P.*	*D.R.G.W.*	*C.B. & Q.*	*C.M.St.P.*
otive type	2-6-6-4	4-6-6-4	2-10-4	2-8-8-4	2-8-8-2	2-10-4	4-4-2
tractive force, lb. (R.T.F)	104 500	97 400	93 000 **	139 900 †	131 800	90 000 §	307 900 ‖
type	Round top	Round top	Round to	Round top	Round top	Round top	Round top
stion chamber	Yes	Yes	Yes	Yes	Yes	Yes	No
s	No	No	Yes	Yes	Yes	No	Yes
ubes	Yes	Yes	Yes	No	Yes	Yes	No
surface, total sq. ft. (F.B.H.S.).	587	625	592	872	715	448	294
rea, sq. ft. (G.A.)	122	108.2	121.5	182	136.5	106.5	69
:							
H.S./G.A.	4.80	5.76	4 87	4.77	5.22	4.21	4.26
H.S./G.A. *	4.33	5.07	3.64	3.35	4.09	2.83	3.68
F./G.A.	856	897	765	765	964	845	445

ed F.B.H.S. less heating surface of arch tubes and/or syphons.

70 per cent. cut-off.

.70 per cent. boiler pressure, 60 per cent. cut-off.

ited cut-off. 61 per cent.

fuel.

able at all other speeds to be determined, remembering that the plotted curves correspond to 40 I.H.P. per sq. ft. of grate, and that as already shown, the values given to the curves would of course vary directly with the fuel used. In other words, a larger value for the In. T.F./G.A. factor may be used for a good quality coal having a high heat content, and a correspondingly lower value for a fuel of poorer quality.

Firebox proportions.

The value of the grate area having been considered, the proportions of the firebox in relation to the grate can receive attention. A study of recent practice shows fairly wide differences between the area of the firebox heating surfaces in relation to the grate surface; and, to show the variations existing, the leading dimensions and ratios typical of modern practice are given in Table I. In addition to particulars of the heating surfaces, the volume of the firebox has been given where this is available from previously published information, and in some instances this has been computed from the drawings. From the proportions shown it will be noted that the heating surface allowed for every sq. ft. of grate varies between the limits of approximately 6 to 3.7, and that where the information is available, the firebox volume in cu. ft. varies from about 4.5 to 6.7 cu. ft. for every sq. ft. of grate area.

A further point of interest may also be noted, which is the relation between the grate area and the rated tractive force, for while this ratio is complicated by the fact that it is governed by the class of fuel used, and the proportion of the maximum tractive force which is required at average running speeds, there is nevertheless a general tendency for the value of this factor to rise when the size of the firebox as shown by the heating surface increases in relation to the grate area. This is only another way of stating that when the grate is relatively small there is a general tendency on the part of the designers to increase the size and volume of the firebox per square foot of grate area. An increase in the ratio between the firebox heating surface and the grate means that the heat receiving surfaces are increased relatively to the heat radiating surface, and that the volume of the combustion space is also increased.

For satisfactory combustion conditions there are two prime essentials, high firebox temperatures, and adequate air supplies. These should be supplemented by means for a proper intermixing of the products of combustion. The maintenance of high firebox temperature depends on the efficiency of the combustion process, and also upon the rate at which the heat is taken up by the water contact surfaces (*i.e.* the heating surface), and for a given grate area the larger the firebox heating surfaces the more rapidly will the heat be dissipated by transfer to the surrounding water. An increase in the heating surface means a larger firebox evaporation and a lower evaporation per square foot of its heating surface, and therefore at the same time a reduction in the temperature of the flue gases.

On the other hand, if the larger firebox heating surface means at the same time an increase in the volume/grate area ratio, then if the volume is effective in improving combustion, that is, by increasing the amount of coal burned in relation to the amount fired, then the capacity of the boiler may be increased; because, though gas temperatures may be lower, the quantity of gas liberated by the firebox will be greater. How far an increase in volume is effective in materially improving the combustion of the coal fired appears to be a question which still requires an answer. The writer is rather of the opinion that the most important consideration so far as steaming wer and efficiency are concerned is e size of the grate, and if this is or can proportioned so as to keep the rate firing at a low figure, or, put in other way, to maintain a low value r the In. T.F./G.A. factor, firebox di-ensions are of less importance.

Referring again to the question of heat sorption by the firebox, and its effect the resulting temperatures, an exami-tion of the data presented relative to ebox proportions, and in particular to e surface/volume ratios, will indicate at design plays an important part. This tio is seen to vary from about 0.93 sq. of heating surface per cubic foot of lume, to a minimum figure of 0.7.

Firebox surfaces and volumes.

The firebox dimensions and propor-ns of a number of modern boilers are ven, as already mentioned, in Table I, d also by Tables II and III; and a ference to examples 11 and 12 which e alike in general design, is interesting showing the influence of shape on the ating surface/volume ratio. Both these eboxes are of the Belpaire pattern, ample 11 being of the type having the be plate pushed forward into the bar-l, so that the lower part of the tube eet and the throat sheet are inclined rward at a fairly steep angle, a con-uction which has the effect of shorten-g the barrel section, and of adding to volume of the firebox between the be sheet and the arch. The other fire-x is very similar in general design, but s a vertical tube sheet of the usual ttern.

It will be noted that the former design es a smaller surface/volume ratio, and t the volume provided for each square t of grate is larger, both desirable tures for good combustion conditions. e one difficulty attending the use of s modified form of construction is that distance between the tube plates ds to become rather short; but to et this the diameter of the tubes may be reduced, and compared with earlier boilers for locomotives of the class for which this boiler is used, this has actually been done. In a similar manner a further comparison can be made by referring to Table II, where columns 3 and 4 compare two fireboxes, one of the Belpaire pattern of a general design and shape used for Garratt locomotives, with a round-top firebox having a fairly large combustion chamber. Here the Garratt type box shows a lower heating surface/volume ratio, possibly due in a measure to the Belpaire form of construction.

In the same table, examples 1 and 2 compare two Belpaire fireboxes of almost identical design, except that example 1 has a very long combustion chamber compared with example 2, which, though also fitted with a combustion chamber has one very much shorter. The ratios given relative to these two fireboxes enable a similar comparison to be made to that between those previously mentioned, and it will be seen that the firebox with the larger volume shows better surface/volume and volume/grate-area ratios. The performance of these two fireboxes on test will now be considered, and as they are equal in respect of grate area, and are practically identical in design, except for the addition in one case of a very extensive combustion chamber extending 96 in. into the barrel section of the boiler, the results are interesting.

Firebox volume and combustion efficiency.

The effect that volume may have on the efficiency of the combustion process is a matter of great importance, because the rather rapid fall in boiler efficiency as the rate of firing increases is due almost entirely to the losses in unburnt coal as the rate at which it is fired becomes greater. In order to furnish some idea as to the effect of volume on the efficiency of combustion, a graph, figure 2, has been prepared based on tests made at Altoona, Pa., on the locomotive testing plant of the Pennsylvania Railroad. The fireboxes compared are those of which particulars are given in Table II, columns 1 and 2. The thick lines in the graph correspond to the boiler efficiencies, and the thin lines show the efficiency of combustion, both being plotted against the firing rate in pounds of dry coal per square foot of grate area per hour. The lines marked 1 refer to the firebox having the larger volume, and a heating surface/grate factor of 5.71; while the lines numbered 2 are for the firebox with the smaller heating surface/grate ratio of 4.1. The following are the firebox temperatures recorded, and the firing rates :

Firing rate, dry coal, lb. per sq. ft. of grate per hour.	*Temperatures (Fahrenheit)*	
	No. 1 Deg. F.	No. 2 Deg. F.
68.4	—	2 560
67.3	2 278	—
127.1	—	2 648
128.1	2 681	—
212.1	—	2 892
231.2	2 577	—

The temperatures are those found near the fuel bed, and have been chosen at as near equal rates of firing as possible. It will be noted that the firebox having the smaller heating surface, in relation to grate area, No. 2, shows the higher temperatures; and that up to a firing rate of about 120 lb. of coal per sq. ft. of grate per hr., both the combustion and overall efficiencies were higher than with the boiler having the larger firebox, but that above that rate of firing the larger firebox with the greater volume showed to a marked advantage. It could be forced to a firing rate of about 320 lb. of coal per hr. per sq. ft. of grate, when the boiler efficiency was as good as for firebox No. 1 at a firing rate of about 220 lb. per hour.

From the results outlined it would seem that, at very high rates of firing added volume is a considerable advantage. Further, as the firebox heatin surface/grate-area factor may be taken as a measure of the volume in relation to the grate area, the remarks previously made concerning the tractive force/grate area ratio and the firebox heating surfaces in proportion to the grate area ar of added interest. In reference to th test results mentioned it is important t note that the coal used in each case wa exactly the same in heat value and othe principal characteristics.

General remarks on firebox design.

The relation between the area of th grate and the rated tractive effort, an also between the firebox heating surfaces and the grate area, has alread been mentioned, and to investigate thes ratios further, figure 3 has been prepared, in which the rated tractive effort pe sq. ft. of grate area is shown plotte against the firebox heating surface allowed per sq. ft. of grate. It is admitted tha the various points in the graph are rathe widely scattered, but a line draw through them nevertheless indicates tha as a rule, designers increase the firebo dimensions when the grate area is smal relative to the tractive effort; in othe words, when the power required per uni of grate is large, that is, when firin rates may be expected to be relativel high, designers as a rule prefer a large firebox.

The firebox particulars shown in Table II have already been mentioned i respect of the first four examples. Th remaining three relate to articulate engines of the Garratt type. The firebo design used for locomotives of this part cular system of articulation is of unifor pattern, that is, the grate is always wid and the length moderate; moreover, th side sheets are straight and slightly inclined from the vertical, the crown shee being of smaller area than the size insid the foundation ring. The tube sheet is rtical. This form seems to provide efficient design from the point of ew of the surface/grate ratio, and at e same time gives a good volume per . ft. of grate. The examples given ow heating surface/grate-area ratios of om 3.96 to 4.55, and, from an examinan the writer has made of a large numr of Garratt designs, it is found that e heating surface per sq. ft of grate lies tween these limits in every case, and is ually about 4.0 or a little more. It ay be noted that in the case where it shown to be 4.55 the box in question equipped with syphons and arch tubes wo of each).

Particulars of very large fireboxes ed for locomotives articulated on the allet system are given in Table III, and will be observed that the heating surces are very extensive, but that, alough this is so, the surface/grate ratios e by no means high, especially when is ratio is calculated by taking the surce of the box and combustion chamber ly. The Norfolk and Western (N. & .), and Union Pacific (U.P.), are two cent designs, and both have large comstion chambers, but the heating surce in proportion to the grate is not ge. The same can be said of the Norern Pacific (N.P.), even though this ebox has five syphons, three in the x proper supporting the arch, and a rther two in the combustion chamber. will be noted that the tractive force r square foot of grate is low, due in s instance to the poor quality of fuel ed, which has a heat value as received m the mines of about 7 000 B.Th.U., d when dried, of about 10 000 B.Th.U.

The last example in the table is the w Chicago Milwaukee St. Paul and cific high-speed Atlantic engine. The ebox is not fitted with a combustion amber, but the tube sheet is pushed ward, and the throat sheet sloped ward to correspond, and there is one syphon. It will be seen that the surface/grate factor is small, and that the grate area (*) is very large in relation to the rated tractive force, thus indicating ample steaming capacity.

Concluding remarks.

The conclusions drawn from these brief notes on the proportions of the fireboxes of locomotive boilers may now be summarised. The volume of the combustion space assumes greatest importance when the rate of firing is high, while at low rates it would seem that a relatively small volume and a small heating surface/grate-area factor give the best results. The temperatures tend to be higher in the smaller firebox at the lower rates of combustion, and, from experimental data at the writer's disposal, the temperature gradient at low rates of firing is steep, and in consequence the gas temperatures at the tube sheet are very low. As the rate of firing advances, the fall in temperature diminishes, so that at very high rates of firing the temperature difference between the fuel bed and the tube sheet is much less. These temperature differences may be about 800° F.; at low rates of firing, and at the middle rates some 600°; and reduced to 400° at the very highest rates. These figures correspond to those observed where the combustion chamber is 8 ft. long, and the total distance from the tube sheet to the grate therefore considerable.

From these remarks, and those made relative to the efficiency of combustion, it is suggested that combustion chambers should be used with caution. The temperature drop at medium firing rates is considerable, meaning a large heat transfer by the firebox, and care should be taken that the gas temperatures are not too low at average firing rates, for this would mean low tube and flue gas

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(*) Oil fuel. Cross-sectional area at foundation ring.

temperatures, possibly affecting adversely the superheat given to the steam.

Consideration of the foregoing leads to the question of syphons, which are now becoming much used. It will be evident that syphons add largely to the firebox surfaces, further, as they are always directly in the gas stream, they abstract heat not only through radiation, but also by gas contact, both assisted by the circulation of the water through the syphon. It would appear that syphons must increase firebox evaporation considerably, and that this being so, ample grate area in proportion to the total firebox heating surface should be provided. The particulars given in Table III support this view. Combustion chambers also require a large grate if flue temperatures are to be maintained fairly high, unless, of course, the rate of firing
considerable.

In general, the writer is inclined to
view that combustion chambers, wh
necessary as a means of keeping tu
and flues within reasonable lengt
should be kept as short as possible. A
heat rejected by the firebox is alw
readily taken up by the tubular heati
surfaces. Combustion volume will ass
the proper burning of the fuel at hi
rates of firing, but, as this conditi
must mean a heavy demand on the bl
and increased cylinder back pressur
it seems logical to suggest that add
grate area is to be preferred as a me
of increasing power output through
greater amount of coal fired and bur
at the lower rates of firing per squ
foot of grate per hour.

NEW BOOKS AND PUBLICATIONS.

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. Sven HELANDER, Professor of Political Economy. — **Nationale Verkehrsplanung** (*National Transport Policy*). — Third volume of a series of scientific treatises on transport, published by the Council for the Advancement of the Science of Transport, at the German Ministry of Communications. — (Price, paper-bound: 7.50 Rm.)

he author's object was to develop theory of a national transport policy, expression being taken to mean a eral organisation of the whole of the nsport of a country, which takes into ount all the objects in view. The nciples he draws therefrom may be lied in different fashions, but they all follow the same general lines, pired by the wishes of the population. o give his investigation a concrete ndation, the author has studied the nsport regulations of a great many ntries (60, to be exact) in the different parts of the world. He has obed his information from German liries, from the reports the railways consulted were good enough to send , and from the current literature lished up to 1936. He was obliged select his material, as the opinions lished are at times influenced by the ure of the publication in which they ear, or the special points of view of r authors.

will readily be appreciated that the sport question appears under very erent guises in so many countries. expound it in a better and clearer , the author has often had recourse ne history of the building up of the vay systems, or the constitution of undertakings operating them. In y cases he has found that the present ation leaves much to be desired, bee it is merely the result of a great y circumstances which could never to a rational system, unless some alizing spirit intervened. To quote one kind of cause which led to e, it will be remembered that lines communication have been built, whose utility was always dubious, seemingly as the result of a mere financial manœuvre. In a general way, his researches, which may be said to have embraced the railways and roads of the entire world, have led him to deplore the absence of some higher authority acting according to standard principles throughout.

In the second part of the book, the author examines the part played by capital cities, as centres of transport systems. The situation from this point of view differs appreciably from one country to another. Whereas certain capitals are the starting point of most of the important railway lines, in other countries the great traffic lines are transverse lines, or avoid the administrative centre. The author discusses at length the effect of the former situation on the concentration of the population, of industry and commerce, and its political and social consequences.

The third part is devoted to exposing the theory of a national transport policy. It begins by a historical review of the attempts made in various countries, even in the remotest times, to set up coordinated transport systems. Here will be found also a summary of the ideas and philosophies of the most famous authors and schools, as well as a brief analysis of the evolution of modern tendencies towards systematizing transport. Under the title : *Capitalist theory of traffic, and organisation of transport,* the author tries to show, by quoting examples and recalling the opinions of well-known economists, the characteristics of the orientation of autonomous undertakings, and the results obtained through their operation. He then studies the influence of an economic monopoly on the distribution of traffic, in order to be able to define his views as regards the organisation of traffic and the general economy. He analyses the relations between the transport policy and the political situation of the State, as well as the value of the different methods of transport from the point of view of national unity.

In the final chapters, the author st dies the influence of parliamentary g ernment and marxist theories on the ganisation of transport, the utilisation the different methods of transport the general organisation, and the effe of the world economic crisis and t plethora of means of transport on t organisation which best meets the ge eral interests.

E. M.

CORRIGENDUM.

Bulletin, December 1936 number.

Recent improvements in steam locomotives of the usual type and tests of ne designs... **Testing locomotives** at locomotive experimental stations... Repor — Paris Congress, 1937 — (*Great Britain, Dominions and Colonies, America China and Japan*), by Sir H. Nigel GRESLEY.

Page 1307/17, Chapter 4, Question 1 (*c*), Table of steam temperatures.

Central Argentine Railway :

Instead of : « 643° F. », read : « Maximum, 375° C. (707° F.) — Average 360° C. (680° F.) ».

Page 1315/25, Chapter 8, Question 2 (*a*), Particulars of pistons.

Central Argentine Railway (column 5) :

Instead of : « C. S. with steel bull rings », read : « C. S. with bronze bull ring cast on ».